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Edward Sabine

MAJOR GENERAL SABINE

R.A.

President of the Royal Society

London, Lockwood & Co. 7 Stationers' Hall Court, 1865.

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IN

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... DISCOVERIES AND IMPROVEMENTS
... THE PAST YEAR;

... NATURAL PHILOSOPHY;

LONDON:

... STATIONERS' HALL COURT.

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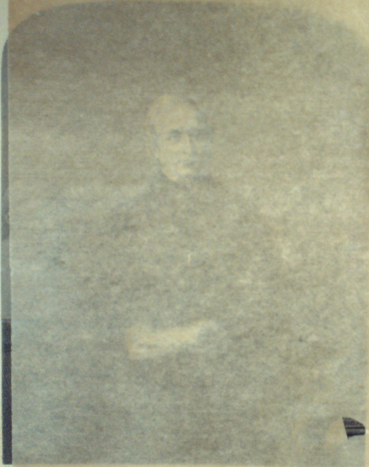
1865



London, Lockwood & Co. 7 Stationers' Hall Court, 1865.

THE

YEAR-BOOK OF FACTS

IN

Science and Art:

EXHIBITING

THE MOST IMPORTANT DISCOVERIES AND IMPROVEMENTS OF THE PAST YEAR;

IN MECHANICS AND THE USEFUL ARTS; NATURAL PHILOSOPHY; ELECTRICITY; CHEMISTRY; ZOOLOGY AND BOTANY; GEOLOGY AND MINERALOGY; METEOROLOGY AND ASTRONOMY.

By JOHN TIMBS, F.S.A.

AUTHOR OF "CURIOSITIES OF SCIENCE," "THINGS NOT GENERALLY KNOWN," ETC.

"It is by efforts such as yours that the foundations of new discoveries are daily laid it is by efforts such as yours that the false clouds of error and prejudice are daily being removed; and the final result of your toil and investigation is the shining forth of the unvarnished truth."—*The Earl of Cork: Proceedings of the British Association at Bath*, 1864

The Clifton Suspension Bridge.—(See p. 88.)

LONDON:
LOCKWOOD AND CO., 7, STATIONERS' HALL COURT.
MDCCCLXV.

LONDON:
SAVILL AND EDWARDS, PRINTERS, CHANDOS-STREET,
COVENT GARDEN.

MAJOR-GENERAL EDWARD SABINE, R.A.,

PRESIDENT OF THE ROYAL SOCIETY.

(With a Portrait.)

THE subject of this memoir obtained his first commission in the Royal Artillery in 1803, at the age of fifteen. In 1804, he made part of the garrison of Gibraltar; from whence, in 1806, he returned to England on his appointment to the Horse Artillery. From 1813 until 1816 he was employed in Canada, where his services on the Niagara frontier, in 1814, procured him favourable mention in the despatches of the Lieutenant-General commanding; and for his conduct he was directed by the Master-General of the Ordnance to wear the word "Niagara" on his dress and appointments. In 1818, and again in 1819-1820, we find him in the capacity of Astronomer—an appointment he obtained through the recommendation of the President and Council of the Royal Society—accompanying the first two Arctic Expeditions, under Captain Ross and Captain Parry, to ascertain the existence of a North-West Passage. He was next, in 1821, 1822, and 1823, employed in H.M. ships *Pheasant* and *Griper* (placed at his direction for that purpose by the Admiralty), in conducting a series of pendulum experiments for determining the figure of the earth, at or near the Equator, on the coasts of Africa and America; and in Greenland, Spitzbergen, and Norway. The account of these experiments, and of a series of magnetic observations and other physical researches made by him in the course of these voyages, was published in 1825 by H.M. Government.

In the same year he was associated with Sir John Herschel in determining the difference of meridians of the Royal Observatories of Greenwich and Paris, by rocket-signals, in conjunction with two French commissioners appointed by the French Minister of War; and in 1827 and 1828, at the request of the President and Council of the Royal Society, in determining the length of the seconds pendulum in the Observatories of Paris and Altona. In 1828 he was appointed one of the Secretaries of the Royal Society, which office he held until ordered to join his regiment in Ireland in 1830, at the time of the tithe agitation. The years 1830 to 1837 were passed partly with his regiment, and partly on the General Staff of the Army; since which latter date, with a brief interval of military service at Woolwich in 1840-1841, he has been engaged in scientific pursuits, and has been at different periods Foreign Secretary, Vice-President, and Treasurer of the Royal Society, and General Secretary and President of the British Association for the Advancement of Science. He has been elected also a member, either honorary or corresponding, of many of the scientific societies in Europe and America, and in 1857 was named one of the thirty foreign members of the Prussian Order of Merit in Science and Literature. In 1821 he received the Copley Medal of the Royal Society; in 1826, the Lalande Medal of the Institute

of France; and in 1849, the Royal Medal of the Royal Society. In 1840 he was entrusted by H.M. Government with the direction and superintendence of the British Colonial Magnetic Observatories, and with the co-ordination and publication of their results; and also of those of the various magnetic surveys, by sea and land, by naval and military officers. In this capacity he has published, under the authority of H.M. Government, eleven quarto volumes, comprising the results of the Magnetical and Meteorological Observatories, and ten Memoirs in the *Philosophical Transactions*, containing the results of magnetic surveys by sea and land. These works are still in progress. Nearly forty memoirs have been contributed by General Sabine to the *Philosophical Transactions*, and eight principal and many minor reports to the volumes of the British Association.

In November, 1861, on the resignation of Sir Benjamin Brodie, General Sabine was chosen President of the Royal Society, and was re-elected to the same honourable position at the Anniversary Meetings of 1862, 1863, and 1864. We subjoin Gen. Sabine's able Report made at the Anniversary Meeting in the latter year:—

THE ROYAL SOCIETY.

General Sabine opened with a few particulars concerning the great Scientific Catalogue, which hold out a prospect of the completion of that important undertaking. The list of *Transactions* and *Journals* catalogued and to be catalogued has been largely increased by correspondence with academies, societies, and learned individuals in all parts of Europe and in America; the numbers of titles of papers already copied exceeds 180,000; and offers of assistance have been received from abroad.

A manuscript catalogue in eighty-two volumes, with more to follow, containing the titles of the several works in chronological order, is placed for use in the Royal Society's Library. The next step will be a printed catalogue of the whole number of titles, arranged alphabetically according to authors' names, accompanied by an alphabetical index of subjects.

By the time the copying and the alphabetical index are complete, the Royal Society will have expended nearly 2000*l.* on this important work. The printing and publishing will of course involve a further expenditure; and on this point General Sabine stated that, after a full consideration of the different modes in which the publication might be effected, the Council of the Royal Society decided that the manuscript should in the first instance be offered to her Majesty's Government, to be printed at the public charge, at her Majesty's Stationery-office, or otherwise, as might be deemed expedient; and that a certain number of copies should be presented to scientific institutions at home and abroad, in the name of the British Government and of the Royal Society; the remainder of the impression being offered for sale at the cost of paper and printing only, and the proceeds applied towards the discharge of the expense incurred in the printing, no pecuniary return being

looked for on the part of the society. In accordance with this decision, the subject had been brought under the consideration of Government, and, as it happened, the official answer was received an hour or two before the delivery of the address. As anticipated, it was favourable. The Lords of the Treasury declare themselves ready to print the catalogue at the public cost, under the authority of the Royal Society. A national character will thus be imparted to the great scientific catalogue which, from all we hear concerning it, it well deserves.

In his previous year's address, General Sabine made some remarks on the expediency of combining pendulum experiments with the astronomical and geodesical operations about to be undertaken in the survey of the great arc of the meridian in India. Since then correspondence on the subject has taken place with the Secretary of State for India, who sanctioned the proposal; and Colonel Walker, superintendent of the Indian trigonometrical survey, has been authorised to carry out the experiments. The Royal Society, being in possession of pendulums and a clock which had previously been employed in similar work, were applied to for a loan of the instruments, which they granted. A vacuum apparatus, in which the pendulums will be swung at all the stations, has been set up in the Observatory at Kew, where Capt. Basevi, R.E., during some weeks made himself practically acquainted with the instruments and commenced a series of base observations. These will be completed early in the year 1865, when the pendulums with the clock and vacuum apparatus will be packed and despatched to India. On the close of the operations in that country, the instruments will be returned and set up in the same place at Kew, and undergo verification. And referring to these preliminaries General Sabine says, "We may not unreasonably anticipate that such experiments may henceforward be regarded as an appropriate accompaniment to the measure of arcs in all parts of the globe." It appears, too, that the science of terrestrial magnetism to which, as is well known, General Sabine has especially devoted himself, is to be promoted by the survey, for directions have been given that instruments shall be provided for determining the absolute values of the three magnetic elements at the Indian stations.

In connexion with this subject, General Sabine mentioned several remarkable phenomena brought to light by the latest of his own researches, namely, the difference of direction observed in disturbances of the magnetic declination at stations in England, and others in similar latitudes in Eastern Asia. The days and hours at which the phenomena occur are, with slight exception, the same, and the movements are simultaneous, in both localities; but the direction of the magnet indicating the disturbance is directly the reverse in Eastern Siberia of the direction in England. On this, General Sabine remarks, "I attach, of course, far more importance to the fact itself than to the hypothesis which guided me to its anticipation, and thence to its discovery; still an hypothesis

which has led to the knowledge of a fact of so much theoretical importance entitles itself to some consideration; while no one can doubt that a knowledge of the fact itself strengthens the desire for the multiplication of stations in distant parts of the globe, at which these phenomena are systematically observed." An instalment of the desire here intimated may be regarded as satisfied, for magnetic observatories, equipped with instruments similar to those in use at Kew, and supported by colonial funds, are to be established at Melbourne and Mauritius.

The other topics of the address are, Sir John Herschel's "Catalogue of Nebulæ;" Mr. Huggins's and Dr. Miller's papers, "On Spectra of some of the Fixed Stars;" and Mr. Huggins's, "On Spectra of the Nebulæ." Mr. Huggins's experimental conclusion as to the gaseous nature of the nebulæ he has examined will be particularly interesting to the advocates of the nebular hypothesis: a question which a few years ago occasioned much excitement among astronomers. The facts appear to be against those who contend that all the nebulæ could be resolved into stars, or stellar points, with sufficiently powerful telescopes.

One other subject remains to be noticed. General Sabine mentioned that the Swedish Expedition to Spitzbergen has returned from the second year of a survey, preliminary to the measurement of an arc of the meridian; and no doubt is now entertained of the practicability of the measurement of an arc of at least three degrees, with a possibility of further extension. The report upon this preliminary survey is to be published in the course of the winter; and the summer of 1865 is looked forward to for the commencement of the arc itself.

The proceedings terminated, as usual, with the delivery of the medals, election of Council and officers, and the anniversary dinner.

The Royal Society have this year (1864) confined the award of their medals to members of their own body. Mr. Charles Darwin, who some years ago had a Royal Medal, has now been selected for the Copley Medal, in recognition chiefly of his long and eminent researches in geology, zoology, and physiological botany. The subjects were ably set forth on the presentation of the medal, and the *Origin of Species* was not passed without comment. As some of our readers may be curious to know what General Sabine said on this much-debated work, we quote his own words: "Although," he said, "opinions may be divided or undecided with respect to its merits in some particulars, all will allow that it contains a mass of observation bearing upon the habits, structure, affinities, and distribution of animals, perhaps unrivalled for interest, minuteness, and patience of observation. Some among us may perhaps incline to accept the theory indicated by the title of this work, while others may perhaps incline to refuse, or at least to remit it to a future time, when increased knowledge shall afford stronger grounds for its ultimate acceptance or rejection. Speaking generally and collectively, we have not included it in our

award. This on the one hand: on the other, I believe that, both collectively and individually, we agree in regarding every real *bonâ-fide* inquiry into the truths of nature as in itself essentially legitimate; and we also know that in the history of science it has happened more than once that hypotheses or theories, which have afterwards been found true or untrue, being entertained by men of powerful minds, have stimulated them to explore new paths of research, from which, to whatever issue they may ultimately have conducted, the explorer has meanwhile brought back rich and fresh spoils of knowledge."

The Royal Medals were awarded to Mr. J. Lockhart Clarke and Mr. Warren De La Rue. Mr. Clarke's investigations have long been known among the best physiologists; they comprise researches on the intimate structure of the spinal cord and brain, and on the development of the spinal cord. Mr. Clarke, instead of using opaque sections of the parts to be examined, devised a process for rendering them transparent, whereby it became possible to trace the finer and more intimate arrangement; and this method has not only, in his own hands, proved fruitful in valuable results, but, having been adopted by his fellow-labourers in the same pursuit, has been most influential on the general progress of the inquiry.

Mr. De La Rue's title to a Royal Medal is, "his observations on the total eclipse of the sun in 1860, and for his improvements in astronomical photography." In what way photography can be employed in the former subject can best be seen in the *Philosophical Transactions* for 1862: the series of coloured plates there published are the best record ever yet produced of the physical phenomena of a solar eclipse. And what can be accomplished by photography in the observation and delineation of other celestial objects has been demonstrated by Mr. De La Rue with success. As General Sabine observed, "No one who has not seen Mr. De La Rue's pictures of the moon can form an idea of their exquisite sharpness and beauty of definition; a result due to his employment of a reflecting telescope of exquisite defining power, the large mirror of which was figured by his own hands, and by peculiar machinery of his own contrivance." To him is mainly due the construction of the photo-heliograph in use at Kew, which is regarded as a model instrument in taking instantaneous sun-pictures; and as he has fully described in print his processes and instruments, he "has thus deepened the feelings of obligation towards him by giving others the benefit of his long experience in the art."

Professor Tyndall's researches on the absorption and radiation of heat by gases and vapours, in which he has been engaged for some years, have met with such ample recognition all over Europe, the account of them having been translated into French, and are so important in themselves, that it was quite natural to expect for him the prize founded by Count Rumford for researches in light and heat. Among the conclusions from these results are,

that the absorption of radiant heat by our atmosphere is mainly due to its aqueous vapour; that gases, when heated, radiate heat in an order corresponding to that of their absorption; and that the opacity of a substance with respect to radiant heat from a source of comparatively low temperature increases with the chemical complexity of its molecule. Referring to this latter fact, General Sabine observed, "Whatever may be thought of our ability to explain the law in the present state of our knowledge respecting the molecular consitution of bodies, the law itself is, in any case, highly remarkable."—*Abridged from the Report in the Athenæum.*

We cannot better conclude our outline of the eminent public services of General Sabine than by recording the support which he proffered at the meeting of the Royal Geographical Society, on January 24, 1865, in aid of Capt. Sherard Osborn's "Project of an Expedition to Reach the North Pole, and Examine the Polar Regions." Upon this occasion General Sabine said, he most heartily concurred in the scheme proposed by Capt. Sherard Osborn. H agreed with that gallant officer that it was of great importance to give to naval officers opportunities of enterprise in times of peace, and he knew of no better field than that offered by Arctic exploration. Many of our most distinguished naval men had been trained in that school. There was no period at which the Expedition could be so efficiently carried out as the present, when so many officers trained in Arctic exploration were still among us, and willing to join in the enterprise; among whom was Sir Leopold M'Clintock, who, he understood, was ready to give up the command of one of the finest frigates in the service to conduct this expedition. On the part of the Royal Society, he might say there was no lack of objects of the highest importance to science which they could suggest as requiring investigation by such an expedition, and he was sure that that society would give its most cordial assistance in preparing the scientific arrangements.

CONTENTS.

THE

YEAR-BOOK OF FACTS.

Mechanical and Useful Arts.

COMPRESSED AIR AND HIGH-PRESSURE STEAM-ENGINE.

Mr. H. James, C.E., has invented a Compressed Air and High-Pressure Steam-Engine, for the economic production of motive power, which is expected to cause a complete revolution in the working of all kinds of machinery. The editor of the *Mining Journal*, in recording this invention, remarks how singular it would be should it so happen that the very same individual who granted to the late George Stephenson the liberty of adopting his invention of the introduction of tubes into the boilers of his locomotive engines, as shown by an agreement between the parties, dated Sept. 1, 1821, to render them suitable for the traction of passenger carriages, for which purpose at that period they were perfectly useless, for want of the requisite power, should now, after the lapse of 44 years, be again suggesting improvements in engines which are likely to produce a still greater revolution than before; the present invention is applicable to every purpose where power is required, at a cost so insignificant as to eclipse everything at present known, in which the combustion of fuel constitutes the active agent for its production. The invention, says the *Mining Journal*, consists in the peculiar construction and mode of working engines by the expansive force of highly compressed air, when heated by, and in conjunction with, steam of still greater pressure; such compressed air being produced and the high-pressure steam introduced into the cylinders of the engines at every revolution. The engines are very similar in appearance, and in their mode of action, to that of open-topped cylinder, single-stroke steam-engines, only that their cranks are made of double, or even more than double, their ordinary throw or lengths, to admit of the working pistons within them being projected by the force of the air and steam through suitable guides to any advisable distance beyond the mouths of the open-topped cylinders; with the double object of allowing the free escape of the air and steam after having actuated these pistons by their expansive force in one direction, and for admitting fresh atmospheric air into the cylinders. The air is compressed by the return strokes of the pistons into vessels attached to the cylinders, or into lengthened portions of the cylinders themselves, beyond the movements of the pistons; and these, during their terminal action upon the air, impinge upon or strike the tail ends of inlet valves, situated in the closed ends of the cylinders or vessels just mentioned, for the purpose of admitting high-pressure steam

into the air so condensed; while the density and pressure of the air can be regulated to any desired degree by proportioning the size of the vessels or lengthened portion of the cylinders to the contents of the working cylinders themselves, for actuating by their joint expansive forces the pistons of the engine when two or more cylinders are employed for the working of each engine; or that of a single cylinder-engine if preferred, but in which latter case a powerful fly-wheel will be requisite for equalising the motion.

A small double cylinder engine has been constructed as above, for experimental purposes. In its working a small boiler is employed for supplying the steam for heating the compressed air contained in the cylinders, in the manner before described, which is also of Mr. James's invention, and constructed upon the cellular principle, which gives it enormous strength, being capable of sustaining a cold-water pressure of 15 tons upon the square inch; and occupying, independent of brickwork and furnace, a space of only 18 in. square by 5 in. deep; the working pressure ranging from 300 lb. to 450 lb. per inch; and that of the compressed air, previous to being heated, 200 lb. per inch; the revolutions of the engine 400 per minute; and the power, as indicated by a friction dynometer, 102,488 lb. raised 1 foot high per minute, or upwards of three horse-power, at an expenditure of fuel of 10 lb. per hour, or 3 lb. per hour for each horse-power. Now, taking into consideration the excessive friction of this engine, arising from the springing of a wooden frame to which it was temporarily attached, and with cylinders so untrue that the pistons would not compress the air within them, except when running at a very high velocity, there can be but little doubt—at all events, such is Mr. James's opinion—that when higher pressures are employed, with improved machinery upon a larger scale, the fuel may be reduced to 1 lb. per horse-power per hour, or even less. Now, supposing his opinion is correct, that it can be so reduced to 1 lb. of fuel, and the weight and space occupied by the engine itself proportionably decreased—which he states will be the case—the value of the invention to the public can only be estimated at millions per annum, and the most distant probability of such a consummation ought to ensure the utmost efforts for its development.

As regards the action of the compressed air and steam upon this small engine, as evidenced by the effect produced by it, the elastic force of the former appears to be so intensified by the heat of the latter, that it can only be compared to that of gunpowder, the engine-cylinders to small cannon, and the pistons to that of the balls, projected at the rate of 800 per minute. The reports produced by the air and steam when allowed to escape suddenly into the atmosphere (which is not permitted in practice, as the noise would be objectionable), are precisely similar to those produced by the rapid discharge of small cannon or musketry.

It is considered that this very simple but important invention will result in the superseding of the present steam-engine on account of its cheapness, portability, and economy, and that it will be found applicable to many novel purposes, for which the present engine is much too unwieldy, cumbersome, and expensive.

LONDON FIRES IN 1864.

The number of Fires during the year 1864 exceeded those of the previous year by 83, and, compared with the average of such

casualties for the last 31 years, the increase is 646. The inference drawn by Captain Shaw is that our fires increase in an undue ratio to the increase in the number of houses and population. Thus, in a period of 25 years, the population of London has increased at the rate of 55 per cent. and houses at 47 per cent. But the annual number of fires in the same period has more than doubled. This is not a pleasing announcement; but there is a gleam of consolation in the fact that the ratio of increase seems to have reached its limit. The number of London fires used to be doubled in every period of 18 years. Since 1840 it has required 22 years to produce the same increase, "and at that point they seem for the present to have taken their stand."

The services of the Fire Brigade were required, during the past year, at 1715 fires. Of these, 101 were false alarms, 127 were "chimney alarms," and 1487 were "fires" within the official definition of the accident. But these are again subdivided. The cases of total destruction or serious damage were 402; the term "slightly damaged" applies to the larger number of 1085. But these returns by no means represent the whole of the danger London passed through in 1864. There is a "usual average" of accidents "of which no exact record is kept," as they were too trifling to require the attendance of the firemen. But, as some of these small fires might have been fed into large ones, we suppose we ought to congratulate ourselves on having escaped so well, as there were no less than 4000 of them, which we are told is the "usual average." To these must be added more than 6000 chimneys on fire, and we have 10,000 cases of this class of accident in the year which had no consequences worth special notice. Taking the year through, the services of the establishment are called for once every five hours.

The organization of the Fire Brigade has been much improved within the last few years. The steam-engine has incontestably proved its superiority over the hand-worked machine. Captain Shaw states that it is no longer advisable to maintain horses to draw the old engines, which might as well be drawn, as they must be worked, by hand. The horse-power should be applied to the transport of light steam machines, and the hand-engine employed as auxiliary to its modern rival. The means of communication by telegraph with all the docks have been completed, and the special lines will soon be extended to the great railways, wharves, and warehouses, in which vast quantities of property are deposited. By the aid of the telegraph the firemen at each station can now be informed of the locality of a fire with much greater certainty than formerly. By means of fixed compasses at each observatory, "cross bearings are taken from distant points," and the result sent to the central station in Watling-street. The exact locality is then ascertained by observing on a map the spot at which the lines converge. The process is "simply the reverse of that by which a ship's position is ascertained at sea," and can be easily accomplished in the three minutes occupied in turning out

an engine. Captain Shaw also proposes to employ portable telegraphs to communicate between the locality of a fire and the nearest station, and between the man at the branch and the man at the engine. This will do away with the confusion produced by "shouting" the orders. It is important to preserve silence at a fire, and to keep off the crowd that always flocks to the spectacle. The City Police have lately adopted a mode of keeping the mob off by stretched wire ropes. And, as they are not now so much employed to work the engines, they are more under control, and the firemen act quietly in a space cleared and kept clear for their exertions.—*Times*.

For the Report of the London Fires in 1863, see p. 59.

INSTITUTION OF CIVIL ENGINEERS.

THE Council of the Institution of Civil Engineers have awarded the following premiums:—a Telford Medal and the Manby Premium, in books, to George Henry Phipps, for his paper "On the Resistances to Bodies passing through Water,"—a Telford Premium, in books, to John Baldry Redman, for his paper, "On the East Coast, between the Thames and the Wash Estuaries,"—a Telford Medal and a Telford Premium, in books, to William Lloyd, for his "Description of the Santiago and Valparaiso Railway, Chili, South America; with Remarks upon Resistances from Curves on Railways, and upon Coal-Burning Locomotives,"—a Telford Premium, in books, to William Parkes, for his "Description of Lighthouses lately erected in the Red Sea,"—a Telford Medal to M. Pernolet (of Paris) for his paper "On the Means of Utilizing the Products of the Distillation of Coal, so as to reduce the Price of Coke; with Descriptions of the Ovens, and of the Best Processes in use in Great Britain and on the Continent, in the Manufacture of Coke,"—a Watt Medal and a Telford Premium, in books, to Thomas Sopwith, jun., for his paper "On the Actual State of the Works on the Mont Cenis Tunnel Victor Emmanuel Railway, and Description of the Machinery employed,"—a Watt Medal to William Bridges Adams, for his paper "On the Impedimental Friction between Wheel Tires and Rails, with Plans for Improvement,"—a Watt Medal to James Cross for his paper "On the Structure of Locomotive Engines for ascending Steep Inclines, especially when in conjunction with Sharp Curves on Railways,"—a Telford Premium, in books, to John Mortimer Heppel, for his paper "On the Closing of Reclamation Banks,"—a Telford Premium, in books, to George Rowden Burnell, for his paper "On the Machinery employed in sinking Artesian Wells on the Continent."

NAPIER AND HOPE'S LONDON SEWAGE SCHEME.

THE Scheme of Messrs. Napier and Hope, for the utilization of the North London Sewage, consists in the construction of a trunk

conduit, with two branches, traversing the whole of South Essex, from west to east; the one branch discharging into the sea on the Dengie Flats, the other discharging on the Maplin Sands, the river Crouch lying between the two branches.

The total length of the conduits will be about sixty miles; and it is now intended to irrigate the entire district along their course with the sewage, which, to a great extent, can be let out of the conduit by direct gravitation on to the lands. Where the levels do not permit this, the sewage will be pumped up into tanks, so as to command the higher ground traversed. Thus the whole length of the conduit is to be considered, they say, as a reservoir from which streams of liquid manure may be discharged on all the surrounding lands whenever required.

At the ends of the two branches the sands are bare at low water for from two to three miles wide, and arrangements will be made with a company already empowered to embank these flats, so as to secure from the sea two large estates, on which the sewage can be advantageously applied. It is not intended at the present time to advance the sea embankments to the full extent of sands uncovered, but only to a perfectly safe and moderate distance, reserving power to extend the enclosures at a future period, so that ultimately 20,000 acres can be reclaimed. But even with the limited area to be at first enclosed, added to the lands commanded in the course of the conduits, it is expected by the projectors that from 60,000 to 80,000 acres will be available on which the sewage can be used.

It has been stated that as much as 7000 or 8000 tons of liquid sewage per annum per acre can be used beneficially; but at Croydon only 3000 tons per acre produce an excellent result. The quantity of the North London sewage will be about 100,000,000 tons per annum, which, if applied as at Croydon, would require 33,333 acres of land only. The working of the company will probably be to apply on such estates as they may acquire or inclose from the sea, the larger proportion of sewage per acre; and, on the farms along the course of their line, such modified quantities as the different crops and soils may require, and such as the farmers will agree to take. The company claim thus to command a large country on which to confer the benefits of cheap manure; a certain outlet on the coast, removed from all but a very thin population; an estate or estates of their own, in the most favourable position for the full realization of the value of the sewage by a scientific application to special crops; and, finally, they offer to the Metropolitan Board a share in profits which they expect will be considerable, and complete relief from risk of claims for damages on account of the discharge of sewage into the Thames at Barking. Mr. G. W. Hemans is the engineer.—*Builder*.

LIFE-BOATS FOR SHIPS AND STEAMERS.

Mr. G. Bell Galloway has read to the British Association a paper in which he proposes, in order that any Boat may be lowered at sea without accident, to fit underneath the "thawt," or cross-seat, at the end of each boat, a roller; the lowering ropes pass underneath the roller, and, when the boat is required for use, such as to save the life of any one who may accidentally fall from the yards or rigging of ships, the men in the watch on deck, as they are termed, have simply to get into the boat, take hold of the lowering ropes, and so lower the boat and themselves immediately, safely, and at once proceed upon their mission of mercy and love to save their shipmate; that having been successfully accomplished, the boat is brought alongside, the ship kept a little off, to prevent damage. The lowering ropes, still hanging to the davits, are taken hold of by the men in the boat, and so passed through the block in the ring-bolts fore and aft of the boat, then after each rope underneath the roller; so the ends of the ropes are then made fast together. So that from the yard-arm or extra davit the ordinary tackles may be applied, as the seamen can at once be made available to lift the boat from off the sea, and thus the boat can be safely lowered, and also again re-hoisted at sea, with the men in the boat, without loss of time or chance of accident.

Mr. Galloway then described his improvement in giving boats more floating power, by affixing underneath the floor of the boat air tubes—say vulcanised india-rubber or metallic tubes, to be secured to the keelson and the timbers of the boat, and covered over, and thus protected from damage by the floor; and so soon as the boat, from becoming damaged on shipping water by pitching or rolling, or from the spray of the sea, has any water within her, the water then in the boat acts immediately in connexion with the air-tubes, and the boat thus maintains her original floating power. Another part of this invention relates to keeping the boat free from water, and thus preventing her sinking in bad weather at sea. This is effected by boring in the bottom of the boat two holes, within which is affixed a valve, and the weight of the water in the well of the boat at each end opens this valve as the boat rises to the sea, when the water will pass out of her, and the pressure of the sea will close the valve as the boat dips or plunges by the action of the waves; thus the boat is kept quite dry and free from water.

The next improvement has reference to extra or external buoyant power, by affixing round the top sides of the boat cork or air-tubes, encased, and secured by rope lashing, which acts also as life-lines, which a person in the water might get hold of; the rope being continued as a loose end to the stern, would be useful. Next, as to shore life-boats, which often cannot approach the vessel because of the weather, &c. To meet this, Mr. Galloway affixes a small brass gun to the side of the boat, to answer as a signal gun in the dark and stormy night, and discharge a plug-shot right across a ship or wreck, the boat cannot in time, or dares not, approach. To this representative rope line, which is affixed to the boat, and the shot to be fired across the ship by the gun, are affixed a few india-rubber rings which represent life-preservers; and when the gun has fired the shot across the ship, the men in the ship or wreck will lay hold of the rope, get the life-preservers secured to themselves, and thus they can be drawn, floating upon the sea, to the boat by the men in the life-boat.

IRON-CLADS FOR RUSSIA.

Messrs. C. Mitchell & Co. have constructed for the Russian Government, in the St. Petersburg dockyard, two iron armour-plated vessels, of which the following are the details:—The *Ne tron Menya* (Touch me Not), the larger of the two iron-clads, is 230 ft. long, 53 ft. broad, and 27 ft. deep. She is covered from stem to stern with armour 5½ in. thick at the water-line, and 4½ in. on the remaining surface of the sides, on a backing of teak 12 in. in thickness. The armament will consist of 20 200-pounder rifled steel guns. The machinery is 450 horse-power, and in addition there is an auxiliary engine for working large pumps and driving a fan-blast to ventilate all parts of the vessel. The draught of water of the *Ne tron Menya*, when fully equipped for service, and with her coals on board, will be 15 ft. The launching draught was 9 ft. 9 in., the entire armour being on the sides, with the exception of 25 plates at the bow, and the same number at the stern, which it was thought desirable to fix after the vessel should be afloat. A rifle-turret similar to the one built on the *Warrior* is placed on the upper deck, is covered with 4½ in. armour, and is provided with electrical apparatus to convey the captain's instructions to the gun-deck, the engine-room, and the steersman. As the *Ne tron Menya* is destined chiefly for coast defence and for service in the Baltic, she will be only lightly rigged. The second iron-clad, built by Messrs. Mitchell and Co., is a double-turret vessel named the *Smertch* (Waterspout), and is about the same size and tonnage as, but in all other respects a great improvement on, the Danish iron turret-ship *Rolf Krake*. The chief dimensions are as follows:—Length 190 ft., breadth 38 ft., and depth 14 ft. The draught of water when in fighting trim will be 10 ft. 6 in., the armour is 4½ in. thick, and extends the entire length of the side, and to a depth of 4ft. below the line of flotation. The armament is carried in two revolving turrets constructed on Captain C. P. Coles's system. These turrets have an internal diameter of 18 ft., and are each capable of carrying two large guns; but being the first turrets on Coles's system made in Russia, it is wished that every facility should be given to insure a successful result, and in this instance but one 300-pounder gun will be placed in each turret. The armour on the turrets varies from 6 to 4½ in. in thickness. The top of the turrets and the surface of the upper deck

are covered with plating one inch thick. The hull is constructed with double bottom and sides, for the purpose of affording safety in the event of the outer shell of the vessel being pierced by a shot, or being run into by an enemy. The space between the outer and inner bottoms is also divided by transverse bulkheads into numerous watertight compartments, each furnished with pipes for pumping out in case of leakage, or for filling with water to increase the immersion of the vessel, and thereby diminish the surface above water exposed to the enemy's fire. The machinery for the *Smertch* has been manufactured by Messrs. Maudslay, Sons, and Field, London, and is of 200 horse-power nominal, divided into two distinct pairs of engines, 100 horse-power each, for the purpose of driving twin or double screws. The object of such arrangement is to usefully absorb the entire power of the engines, which could not be done so well with one screw on so limited a draught of water, also to give the vessel increased power of manœuvring while in action. For a like purpose a balanced rudder has been fitted in the bow of the vessel. The *Smertch* is rigged as a three-masted schooner, the fore and main masts being of iron, and constructed on Captain Coles's tripod system. The two vessels were launched on the same day.

THE METROPOLITAN MAIN DRAINAGE.

In the *Year Book of Facts*, 1864, pp. 101-103, we recorded the commencement of the Main Drainage Works, and gave a general outline of their stupendous extent. Of the works north of the Thames, the Northern High Level Sewer, 9 miles in length, has been completed; and the Northern Outfall Sewer, consisting of 5½ miles of double and treble sewers; the Middle Level Sewer, 12 miles long, has been completed, or nearly so; and the Northern Outfall Reservoir, for the storage of sewage. The Northern Low Level sewer is, of course, greatly dependent on the progress of the Thames Embankment, of which it forms an integral part. Already, however, about 5 miles of it have been constructed; whilst of the Western Sewer, over 4 miles have been made. Of the works South of the Thames, the Southern High Level Sewer, 9½ miles long, has been completed; and of the Low Level Sewer, nearly 7 miles have been constructed; as also the Bermondsey Branch Sewers; the Southern Outfall Sewer; and the works at Crossness have been proceeded with. "It is satisfactory to know," says the *Companion to the Almanac*, "that the drainage of a large part of the North, and the whole of the South, side of the Thames, or nearly half the sewage of London, is now discharged into the Thames at Barking on the North, and Crossness on the South, 'so far out of the metropolitan limits, and at such a turn of the tide as to carry the obnoxious fluid seawards,' and beyond danger of injuring the health of this great city."

For a more comprehensive account, we refer the reader to the *Builder* of the year 1864, articles at pp. 467, *et seq.*, 486, 521. These several articles, in part technical, are popularly descriptive.

NEW GUNS.

Experiments have been made on the shore at Crosby, near Liverpool, with a large wrought-iron Gun, made by the Mersey Steel and Iron Company for Mr. Mackay, of Liverpool. The trials were of a preliminary nature, intended to ascertain the general capabilities of the weapon, and to test the velocity of cylindrical shot of various weights with graduated charges of powder. The initial velocity was taken by an electrical apparatus, somewhat similar to that used at Shoeburyness. With a projectile weighing 100 lb. and a charge of 20 lb. of powder, the initial velocity obtained was 1508 feet per second. Although the wind blew in fitful squalls half a gale across the range, several shots went through the targets, which were placed at distances of 1000 and 1500 yards. The weight of the gun is about nine tons, and the bore is 8·12 inches diameter. The peculiarity of the system invented by Mr. Mackay is that the shot are plain cylinders, and although the gun is rifled, the projectile has no corresponding adaptation. There is, however, a rotation produced quite sufficient to keep the shot true in its course, as shown by the holes in the targets, which were the exact diameter of the shot.

Since these experiments several important improvements have been carried out in the construction of the gun, as regards its length of tube. The projectiles are perfectly cylindrical and smooth, admitting of no expansion, and requiring no extraneous wrapping of lead or other material to fit them to the groove of the gun, as in the case of all rifled firearms. The gun is practically a smooth-bore piece of ordnance with windage grooves, and from that circumstance sustaining no injury whatever from any number of times it may be fired; the shot being simply forced out, rotating on its longitudinal axis by the action of the revolving explosive gases, which lift it upon the axis of the bore at the initiatory explosion of the powder; thus conferring on it a very high velocity and great accuracy of flight, without producing any friction on the bore of the gun, the whole of the gases and the shot being discharged from the muzzle at the same instant. In the experiments which have been made with this 12-pounder gun, these peculiarities have been fully demonstrated. To a very extensive range it has been satisfactorily shown that the projectile is propelled with wonderful accuracy of aim, as may be readily inferred from the following details:—In No. 1 round, with 1¾ lb. of powder and at an elevation of 14 deg., the first graze reached 4700 yards; at the same time, in subsequent rounds with a similar charge of powder, at 10 deg. of elevation, the average range of five rounds was 3845 yards, the maximum being 3856, and the minimum 3810. Since the experiments above alluded to were carried out, a small alteration was made in the gun with a view to increase its extent of range. This was found to be an improvement, and, with various lengths of projectiles, these results were obtained. With 1¾ lb. of powder, at an elevation of 10 deg. by quadrant, the following ranges were made:—No. 1 round, first graze 3830 yards; No. 2,

3850 yards; No. 3, 3850 yards; No. 4, 4000 yards; No. 5, 4250 yards; No. 6, 4275 yards. It will be seen from the above statement that the Mackay gun and projectiles secure a much greater amount of range than the Armstrong 12-pounder, which at the same elevation, we find in the *Handbook for Field Service*, by Col. Lefroy, date 1862, only attained a range of 3590 yards.

Mr. Mackay has since tested his new 7-inch Gun on the shore at Crosby, where two shots, weighing 12 lb. each, were fired with
99 20 lb. of powder. The first shot, at 10 deg. elevation, made its first graze at 4,252 yards; and the second, at 13¾ deg., reached 4700 yards before grazing. On Jan. 7, 1865, Mr. Mackay fired a shot 14 in. long, and weighing 116 lb., with 20 lb. of powder, from the 7-inch gun, at 25 deg. elevation: the shot was found buried in the sand (first graze) at a distance of 7153 yards from the gun.

A Gun, stated to be of entirely novel construction, has been patented by Major-General Hutchinson. The objects sought to be accomplished in the new gun are—first, that it shall weigh little more than twenty times, instead of upwards of 800 times, the weight of the shot, as is usual; secondly, that without friction it shall impart rapid rotation to the shot; thirdly, that the shot shall be of the form best adapted for penetrating the air and target; and, lastly, that it shall leave no vacuum behind it, and not ricochet when it strikes water. The gun is somewhat like a lengthened mortar. The chamber is of the usual cylindrical form, but only sufficiently long to hold the powder and wadding. It is at the mouth that the chief peculiarity occurs. The shot is termed disc shot. Those used in the first experiment were about the size of two very small plates placed against each other, excepting that the edge is sharp. The muzzle of the gun is much enlarged, and is formed so as to receive with great exactness the inner half of the disc shot. The more accurate the fitting is the less the escape of gas and the truer the aim that can be taken. When in place the outer edge of the shot is flush with the muzzle of the gun. The shots weighed 4 lb. 2 oz. The charge of powder 6 oz., being 1-11th part of the weight of the shot, whereas the usual proportion is about one-fourth the weight of the shot. The gun was of nearly 200 lb. weight, double, the inventor said, what it ought to have been. The first trial was at the 1000 yards target. The shot went in a good direction, and pitched 100 yards beyond the mark. The other two experiments were at 13 deg. elevation for range, and 4 deg. for aim. In neither case could the position of the shot, when they fell, be observed. The tide was out, and doubtless on striking they, from their rotation, buried themselves in the mud. The experiments, as far as they went, were considered satisfactory. When in the gun the shot stands in a vertical position, and rotation is caused by the axis of the chamber lying above the centre of the shot, and by a small projection in the interior of the muzzle, at the bottom, meeting the edge of the shot. From the shortness of the gun it possesses all the advantages of a breech-loader, and from the simplicity of its construction and the little metal used it

promises to be both a cheap and easily-handled weapon. The projector may be too sanguine, but he avers that one weighing no more than the ordinary 68-pounder will discharge a 600 lb. disc. The carriage is fitted with a number of galvanized India-rubber cylindrical buffers (in contact by their sides, not extremities), placed in grooves on the flank of the gun; these received the recoil. By a simple mechanical arrangement the rebound was received in a similar manner on a series of rings fixed below the gun. This disposition of India-rubber rings the inventor prefers to any compressors, as they do not make the gun "jump," to use the technical expression.—*Abridged from the Times.*

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BURSTING OF A MONSTER GUN.

The Trenton (N. J.) *Monitor* states that the Monster Gun, cast at the Wiard Ordnance Works, has been subjected to so severe a test as to cause its almost total destruction. Though of but 15 in. calibre, the gun, from its peculiar pattern, was probably the bulkiest piece of ordnance ever made in America, being 13 ft. in length, over 6 ft. in exterior diameter, and weighing over 46,000 lb. The charge was far greater than any ever before attempted, consisting of 80 lb. of quick burning powder, and an elongated shot of 900 lb. weight; the cartridge was 15 in. in diameter by 15½ in length, the ball a solid double shot 15 in. by 24. This is more than three times the service charge. The gun was fired about dusk, and caused an explosion by which many in the city, at the distance of two miles, were much alarmed. When the clouds of smoke and gravel had subsided, it was found that the gun had been blown to fragments, one piece of about 15,000 lb. weight being hurled a distance of about 200 ft.

RUSSIAN ARMOUR-PLATES.

In April last the first of a series of enormous iron bars, ordered to be rolled by the Millwall Iron Company for the Russian Government for the construction of a powerful iron fort at Cronstadt, was rolled most successfully. It is now some years since efforts have been made to induce our own and various Governments to sanction the adoption of iron instead of granite in important land forts; but it is only recently, and since the construction of the Iron-clads have proved the value of the system, that the proposal has been entertained.

In the above experiments, each bar when delivered was to weigh six tons, to be 15 inches square, to be tongued and grooved in the rolling, and to be perfect in its soundness throughout. The furnaces were opened, and the immense mass of metal was drawn forth on to an iron truck, heated to a brilliancy that was almost blinding in its intense whiteness, and instantly changing the temperature of the vast factory to a scorching sulphurous heat that was insupportable. Directly it was out, workmen shielding their faces as they best could, swept the impurities from its surface, with long brooms soaked in water, but which nevertheless lit like

tow, the instant they came in contact with the iron, which was sparkling like a gigantic firework. It was then let down the incline to where the rollers, turned by one of the largest fly-wheels in the kingdom—more than 100 tons weight, and nearly 40 ft. in diameter—was waiting to crush the mass into its required form. This was the critical moment: for an instant or two the rollers failed to grip it, but at last they caught it, and the whole machinery moved slower, as amid loud cheers from the workmen they began to wind it in. As it was slowly crushed through, the refuse melted iron was squirted out in showers in all directions, and as the mass emerged from the rollers on the other side it lit up everything with a bright, lambent flame, said to be caused by the pressure to which the bar was subjected. This was only the first roll, but it had to be passed through three times to reduce it to its proper thickness. It was not, however, as in the case of ordinary armour-plates, a mere question of reduction, as these bars have to be rolled, tongued, and grooved to fit into each other. Thus in the rolling they have to overcome all the peculiar difficulties of their construction almost in two operations, which must be done while the metal is in a half-melted state, or the whole is spoilt. The bars, as we have said, are 15 in. square, but each of these presents a most difficult section. In the first place, the lower part of the bar has a projecting rib, and in the upper part is a groove, corresponding in size with the rib on the lower half, so that the projection of one bar may fit into the groove of the one beneath, thus making a solid dovetailed wall of iron. Beyond these, also, is a rib at the back of the bar, formed to dovetail again into projecting masses of iron in the rear supports of the fort, and in the process of rolling all these departures from a plane and smooth surface have to be formed, and to be formed with so much accuracy that each part fits into the other, without the necessity of any machine planing of surfaces. To give to the mass of metal the required section the rollers of the mill are grooved where the raised surface is required, and sunk to produce the projecting ribs. It took three rolls before all was finished, and at the completion of each, the workmen, who seemed intensely interested in the success of the experiment, cheered loudly. The last operation was effected by lifting the bar into a bed, so to speak, made between two masses of iron, and then passing over it an enormous iron roller, which removed the curved form the bar had received in passing through the rollers. When the fort is erected in Russia, it is intended to test its powers of resistance with a gun throwing a shot of a thousand pounds weight, which is in a short time to be cast in Prussia for the Imperial Government.—*Times*.

GUNNERY EXPERIMENTS AT SHOEBURYNESS.

IMPORTANT as are the trials of these stupendous weapons, to report their details would occupy space far beyond our limits; and we are only able to select a few of the more striking results.

Thus, in the April trials, at the 300 yards, the Whitworth put all five shots into the bull's-eye, and in fact, carried it away; the shunt and the breech-loader also shooting well. The extraordinary accuracy of this shooting will be appreciated if we explain that the bull's-eye is about the size of the crown of a hat. At the 400 yards, the shunt Armstrong made the best shooting. At 500 yards the Whitworth made one bull's-eye, the Armstrong guns also shooting well, the muzzle-loader having the better diagram, as it had again at the 800 yards. At the 900 yards range the breech-loader made the best target of the three.

In the Target Practice of this date, the attack began at 1300 yards, with five rounds solid shot. Several shots struck low, and only two passed through the targets. On entering the work not a man (of the dummies) was found to be hurt, neither was the work at all injured. The shunt gun fired more regularly into the embrasure than either of the other two. The shell practice now began, the Armstrongs firing the segment shell, and the Whitworth the shrapnel shell invented by Colonel Boxer; all the shells having fuzes which were both time and percussion, that is, if they missed exploding by the time fuze, they burst on contact. Every one expected to find the representative gunners much cut about after five rounds of these explosive missiles, of which we have had such terrific accounts; but on getting into the battery it was found that out of the 18 men only one might be considered killed, as the wooden shako that did duty for a head was split off, and two others were wounded. The whole of this, however, was done by the Armstrong segment shell, from the breech-loader; not a man was touched at the other guns. As to the work itself, it remained very little injured indeed, and the marks of fragments upon the targets were very few, considering that each shell burst into 72 pieces, most of which pieces flew over to seaward. The service segment shell, therefore, proved itself the most effective missile. It would seem from this experiment that rifled shot and shell are not so effective against a work of this nature as spherical shot and shell, as they pierce the earth and burst harmlessly, when the spherical projectile would ricochet straight or burst on the face of the work. The next thing was to fire shot and shell, common shell, and segment shell, at the embrasures and the merlons (spaces between the openings), at 900 yards. The loading of the monster 600-pounder was commenced. It takes four strong men to lift the shot on an iron frame, and when it is brought to the gun a strong tackle of ropes and pulleys, with a sheer leg, is fixed on, and eight or ten men haul up the shot, and it is then rammed down upon the charge by a large rammer worked by four men. The charge is 90 lb. of powder, but on this occasion the gun was fired with only 70 lb. The target was formed of two old plates made by Brown and Co., the upper one 6½ in. thick, the lower 5½ in., backed by 18 in. of teak upon a strong skin of one inch, and frame of iron ribs and balks of timber. The supporting part of the target was the old box target which was penetrated by the Whitworth shell in November, 1862. The gun was fired at this, from a distance of 200 yards, at a bull's-eye painted on the thicker plate, with a solid steel shot, conical-headed, weighing 612 lb.

This tremendous projectile struck just above the bull's-eye, drove in a piece of iron rather larger than its diameter, and then entered through the timber and skin of the ship, falling in the chamber. The wood was much smashed up, but the plate stood well around the hole, not showing any important fracture, with the exception of the piece immediately above the opening, which broke away to the edge and lay in the opening made by the shot. It was remarked that the effect was not quite so destructive as might have been expected, considering the enormous explosive force employed and the great weight of the shot. It was not, comparatively, so destructive as the Whitworth 70-pounder shell, which pierced the Bellerophon plate $5\frac{1}{2}$ in. thick, with a charge of 25 lb., at the same short range; to say nothing of the cost of employing a gun of this magnitude, which was not made for less than 4000*l.*, and costs every time it is fired not less than 30*l.*—*Daily News.*

In June, a very important series of Gunnery experiments took place at Shoeburyness. The object was to test the resisting powers of a Target representing a section of the iron-clad *Lord Warden;* and in the same trials to determine the comparative penetrating powers of the Somerset and Frederick guns, and of the Armstrong and Anderson guns.

As regards the guns, the points to be determined were, first, whether the $6\frac{1}{2}$-ton Somerset gun of 9·22 in. bore, or the $6\frac{1}{2}$-ton Frederick gun of 7 in. bore, possessed the greater destructive power; and, second, whether the $12\frac{1}{8}$th-ton Gun-factory gun of 9·22 in. bore, or the $11\frac{3}{4}$-ton Armstrong gun of $10\frac{1}{2}$ in. bore, possessed the greater destructive power. Then the results of the two pairs of guns would show whether the $6\frac{1}{2}$-ton guns or the 12-odd ton guns did their work better. The Somerset is a handsome gun, on the Armstrong tube and coil construction, with Armstrong shunt rifling. The Frederick gun embodies Admiral Frederick's small-bore gun theory. The gallant admiral has long supposed that by the use of a small bore, as compared with a large bore, in guns of the same construction, more penetrative power would be obtained, because the greater mass of metal in the small-bore gun would admit of heavier charges than in the large-bore gun. The gun is constructed on the tube and coil principle of the Armstrong, with shunt rifling. Unlike the Somerset, the Frederick is an unsightly gun. Such are the first pair of guns—Armstrong shunt-muzzle loaders, of the same weight, but of different calibres. Then the heavy factory gun, or the Anderson, as it has been called, is identical in pattern with the well-known Armstrong 300-pounder. From the Armstrong it differs only in the bore, and in the substitution of a steel barrel for a wrought-iron barrel; the barrel on which the first and other layers of coil are laid. Recent improvements or extensions in the manufacture of steel have enabled Mr. Anderson to make this change, as Sir William Armstrong has done of late, and as Mr. Whitworth, following Sir William, has also done in his built-up 70-pounders. The second pair of guns, therefore,

like the first, are Armstrong shunt-muzzle guns, nearly of the same weight, but differing as before in calibre.

The weight of the section of the *Lord Warden* fired at, is stated at 400 lb. per square foot. The official description is that of a target 20 feet by 9 feet, representing the ordinary construction of a wooden armour-clad ship, with the addition of an iron skin worked outside the frame of the ship. The scantlings are—frame timber moulded, $12\frac{1}{2}$ in.; iron diagonal sides, connecting the frame timbers, 6 in. by $1\frac{1}{4}$ in.; inner planking, 8 in. thick; iron skin, $1\frac{1}{2}$ in. thick; outside planking, 10 in. thick; rolled armour-plates, $4\frac{1}{2}$ in. thick. These scantlings were through-bolted, with bolts of $2\frac{1}{2}$ in. diameter. Then in the rear of the target there were the deck beams—lower, 15 in. by 12 in.; upper, 16 in. by 16 in.; waterway, lower, 15 in. by 15 in.; upper, 13 in. by 14 in.; deck planking, lower, 4 in.; upper, 4 in. In a word, the target was a perfect section of the ship now building, with lower deck and upper deck, lower beams and upper beams, &c. The ironwork of the target was the produce of the Millwall Ironworks. Battered to ruin as the target was, the armour-plates were uncracked, and the bolts proved as unexceptionable as the plates.

The first round fired was from the service 68-pr., steel shot, 16 lb. charge. The shot produced an indent of 3·6 in., striking the head of an armour bolt, and starting a bolt in the rear. No one on board the ship would have been injured; therefore the *Lord Warden* may be said to be proof against the 68-pr. fired, not with cast-iron shot, but with steel shot. The velocity of the shot was 1500 feet per second.

In the second round the Somerset 9·22 in. $6\frac{1}{2}$-ton gun, steel round shot, weighing 100 lb.; charge, 25 lb. The shot struck at the waterways, where the target presented an aggregate thickness of $42\frac{1}{2}$ in., passed through the outer armour-plate, and imbedded itself in the backing. The waterway, 15 in. by 15 in. beam, was cracked through, but there were no splinters. This was a shot in the strongest part of the ship, and showed that a ship of even $42\frac{1}{2}$ in. thick would in time be smashed by the $6\frac{1}{2}$-ton 9·22 in. Somerset. The velocity of the shot was 1540 ft. per second.

The next round was fired from the same gun, steel shell, weighing empty 171 lb.; charge, 20 lb.; and bursting charge, 7 lb. The outer plate was passed, the woodwork cracked right through, and the armour-plates started. The shell effect was trifling.

In the succeeding practice the Somerset beat the Frederick gun. The Somerset made the larger hole, the hole of the 9·22 in. against the 7 in., with the same charge of powder, and exhibited the greater penetrative power. In other words, the large bore beat the small bore with the same charge and the same weight of gun. The velocity of the shot was 1560 ft. per second.

The Anderson gun, $12\frac{1}{8}$-tons, sent a 220 lb. steel shot with 44 lbs. of powder clean through the target, but at its weakest part, namely, on the top of the shelf below the upper deck beam, where the thickness is only $27\frac{1}{2}$ in. instead of $37\frac{1}{2}$ in. and $42\frac{1}{2}$ in. as elsewhere.

A cast-iron shot from the Somerset gun also passed through the outer plate, the velocity being 1260 feet per second.

The ninth round was fired from the Armstrong $11\frac{3}{4}$-tons, 10·5-in. gun, 301 lb. steel shot; charge, 45 lb. This was a most destructive shot, passing right through the whole structure, filling the deck with heavy splinters, and throwing an iron knee of 3 cwt. 2 qrs. 21 lb. a distance of 20 yds. The shot, after passing through the target, struck an immense granite block and broke into four pieces, one of the pieces bounding off a further distance of 50 yds. Three rounds more from the Anderson and Somerset guns terminated the experiments by completing the destruction of the target.

Perhaps the most important firing and progress at Shoeburyness ever yet recorded took place in July. The question to be decided was no less than the continuance or the abandonment of the construction of the Spithead forts. The whole problem lay in the amount of damage which a heavy gun can inflict at a range of say 4000 yards. In order to ascertain this, it is by no means necessary that such a range should actually be employed; a little calculation is sufficient to prove that a gun, the service charge of which is 90 lb. of powder, and the initial velocity of the projectiles of which is 1200 feet per second, will, when the initial velocity is reduced to 860 feet per second by a charge of 40 lb. of powder, give the equivalent result to firing at 4000 yards, by merely firing at 200 yards. Accordingly, the 600-pr. has been fired with 40 lb. to ascertain what the execution of that gun would be at 4000 yards, when fired with 90 lb. of powder. The execution was terrible; much more so than when the same gun was fired at the same range with 90 lb. of powder. Both shots will very likely long remain on the same target, so that what we are here stating admits of very easy verification. The target fired at was that made of box oak, faced with Brown and Co.'s 6½-inch plates, and the point of impact was the top or deck part, so that behind the 6½-inch armour-plates there were little less than *three yards* of solid oak and old iron target. The shot struck the armour-plate, went through it, throwing an armour-plate fragment of 2 cwt. a distance of 25 yards, together with a perfect shower of massive oak fragments. Nor was that the whole damage. On inspection it was found that the woodwork was very much crushed in. On the spot, among the scientific men and officers present, there was but one opinion, and that was, that the strongest iron-clad that would swim would be smashed to atoms by the 600-pounder gun at 4000 yards. On the spot it was also stated that the Americans had not been able to fire more than 40 lb. of cake powder in their 600-pounder gun, and that one of them had burst with that charge. Cake powder possesses 15 per cent. less strength than our powder.

The general result of these experiments is sufficiently remarkable to prove that we know very little indeed about guns and gunnery. Thus we find that with the same charge and projectile, the penetration of the Whitworth shot was greater at 800 yards than at 50! With the shunt gun shell penetrated more deeply than solid shot.

Gunners state that the velocity of projectiles increases after they have left the gun for a short space. Hitherto the statement has been denied, but these experiments apparently open up the possibility of the correctness of the theory after all.

That both the scientific artillerists, Sir W. Armstrong and Mr. Whitworth, have made improvements in their weapons is admitted. Sir W. Armstrong has been enabled to use steel for the principal part of his guns, by finding that that metal could be produced of the right standard of excellence. Mr. Whitworth always upheld steel of the proper kind, but had not till now been satisfied with the quality of the metal, and the means of working it under the hammer in the large masses required. This important difference in material between the two kinds of guns remains, however—that the Armstrong guns are strengthened by coils of iron shrunk on in layers upon the steel tube where it is required to resist the force of the explosion, while the Whitworth gun is made entirely of homogeneous steel, the rings of metal being forced on in a state of tension by hydraulic pressure, these strengthening portions not being coiled, but cast and hammered. Therefore two very different methods of constructing the material of a gun are under trial. Then we have the systems of rifling, which are also exceedingly diverse. The Armstrong system requires a lead-coated shot or shell, to be forced through a polygroove bore from the breech, while the Whitworth system employs iron or steel projectiles, shaped to fit a polygonal bore so nearly as to leave only a very small space for windage, and loads from the muzzle. Mr. Whitworth has, we believe, given up all idea of producing a breech-loading gun, and does not compete in this trial with the breech-loading piece he once invented. But Sir William Armstrong now competes with his shunt guns in addition to the regular Armstrong gun of the service, and these are muzzle-loaders, firing iron and steel projectiles with studs upon them, which work in grooves of the bore. These guns are by no means a novelty now, for they have been repeatedly tried at Shoeburyness, and generally, if not always, with superior success to the Armstrong gun. The 600-pounder is a gun rifled on the same principle, very closely resembling that adopted by the French artillery and several other services.

At the Conversazione of the Institution of Civil Engineers, not the least curious thing shown was a 68-pounder cast-iron shot, made of Dr. Price's iron, which had been discharged against an armour-plate at Shoeburyness. The shot is flattened into the shape of a melon, and is cracked into fragments in every possible direction, but all these fragments hold together, nevertheless; displaying an amount of toughness which is remarkable to a degree.

Leaving out of the question altogether the 600-pounder, the 150 and 220-pounders which are now at Shoebury have proved themselves sufficient to destroy almost at a blow every target that has been put before them, even such targets as inventors have brought forward, where the mass of iron has been so great as to at once render it evident that it could not be borne in sea-going ships. For mere harbour-duty, a floating battery with steam-power enough to steam in or out of Spithead may be made to carry 12 inches, or even 15 inches of iron. For sea-going frigates 6 inches seems as yet to be the utmost limit of weight which they can safely carry, and 6 inches of iron before these heavy Armstrong shunt guns represent the same powers of resistance that wooden ships offer to 68-pounders. The guns have always kept an important relative superiority over the armour, and are likely to keep it to the end.—*Abridged from the Mechanics' Magazine.*

TRIAL OF AMES'S WROUGHT-IRON GUN.

A CONTEMPORARY states that the preliminary trial of the Ames's wrought-iron rifled cannon named the Union has been made at Bridgeport, Connecticut. The site selected is about one and a half mile from the railroad depot, directly on the shore of Long Island Sound. A vessel had been chartered to measure by log and soundings a distance of five miles directly off from the shore. When the distance was reached a signal was given, and the gun-charge was fired at an elevation of 20 deg., with a 16 lb. and one of Hotchkiss's 150 lb. shells, which passed beyond the vessel at least half a mile, throwing up a volume of water to a considerable height. The vessel was then anchored, the shore being six miles, and the light boat four miles distant. The shell was fired with a charge of 25 lb. of powder, the elevation of the gun being increased to 24½ deg. The flight of the shell occupied 30 seconds, and fell considerably more than a mile beyond the vessel. The recoil of the gun at the last discharge was a trifle over two feet. The manufacturer has orders from the Government for 15 of these guns, which he will be able to deliver at the rate of one in every ten days. The gun is constructed on an entirely new principle, consisting of successive layers of wrought-iron rings compactly welded into a solid mass. The inventor is of opinion that the charge of powder may be increased to 30 lb., so as to gain a still greater range. So far as this partial trial affords evidence, the "Ames's" gun exceeds in range all American guns by about two miles.—*Mechanics' Magazine*, Oct. 7, 1864.

NEW SHOT.

SOME experiments have been tried with the chilled cast-iron Shot, cast on Captain W. Palliser's principle. Hitherto the effect produced by firing against armour-plates with common cast-iron shot has been almost absolutely nothing. During the last two or three years, however, Captain Palliser, of the 18th Hussars, has conducted, at his own expense, a series of most important experiments on casting shot in cold iron moulds instead of hot sand ones, by which, without adding a fraction to the cost of casting, but on the contrary, reducing it by about 1d. per shot, he chills the outside of the metal into the hardness of steel, and obtains a cast projectile which costs about 2s. The shot tried were only 100-pounders from the Frederick gun with a 20 lb. charge, but in every case they went clear through the 4½ in. armour-plate and deep into the backing beyond. One of the peculiarities of Captain Palliser's most valuable discovery is, that after accomplishing its work through the armour-plate, his shot breaks up into minute fragments of from four to eight ounces weight, so that, in fact, the projectile carries in itself almost the penetrative powers of a steel shot, and the explosive fragments of the most powerful shell. As far as the competition with various kinds of steel shot has gone—and there is nothing

yet to come which seems likely to affect the broad general results already obtained—Mr. Krupp's metal has been the best; John Brown and Co.'s shots have been the next best, and close upon Mr. Krupp's; and Mr. Attwood's have been the next best to Mr. Brown's. There has been, however, a wider margin between the performance of Mr. Brown's and Mr. Attwood's shots, than there has between Mr. Brown's and Mr. Krupp's. Mr. Brown's metal has been very close indeed upon the excellences of Mr. Krupp, though Mr. Krupp's price per ton is, it is stated, nearly double that of Mr. Brown's—a difference of cost which is in no way justified by the difference in performance. Mr. Brown has supplied his steel shot to the Committee at 35*l*. per ton, while the cost of Mr. Krupp's metal is stated at 50*l*.; a difference of nearly 70 per cent. in price, when there is certainly not a difference of 10 per cent. in effectiveness. Judging from what Krupp, Brown, and Attwood have each accomplished, there is no reason to doubt but that the steel of the last-named maker, at even 40*l*. per ton, would be to the full as cheap for this country as Mr. Krupp's at 50*l*. One important fact, however, has been ascertained by these trials—that even 5 in. plates unsupported by backing are insufficient to keep out steel shot when fired from the Armstrong breech-loader with a 10 lb. charge of powder.—*Times*.

ARTILLERY EXPERIMENTS AT PORTSMOUTH.

Now that the competitive firing with the naval 70-pounder Gun has concluded, the labours of the Special Committee charged with an inquiry into the future armament of a certain description of her Majesty's ships of war may be said to have terminated. The *Times* looks upon the Committee as an anomaly from first to last, although admitting that they have certainly not been a greater anomaly than the present laws and arrangements which include the armament of the navy in the army annual estimates. These anomalies, it considers, have led to errors and confusion in relation to the outfit of her Majesty's ships; have had a most prejudicial effect upon the important question of their armament, and have very nearly rendered worthless the facts obtained from the experimental shell firing by these 70-pounder guns at Portsmouth. "It has been in fact but a trial of fuzes, and even then a lamentable mistake. If a comparative trial of the guns and shells had been simply intended, the use of the 'Petman' fuze (the best known description of percussion fuze we possess) would have given the required comparative results, and results which might have been implicitly relied upon for their correctness. Instead of this course being taken, however, the Committee unfortunately allowed the fuzes to be supplied with guns and shells, and hence the trials degenerated into a trial of fuzes, deposing the main feature of the trials—the merits simply of each gun and its shell. To this serious deviation from the straight course, which it must be supposed was laid

down in the official programme of the Committee's duties, was afterwards added the additional error, and consequent confusion, of a wrong selection of the Whitworth fuze for shell firing *en ricochet*." "If the guns are considered in relation to iron-plated ships and iron-plated fortifications, the future fighting material of every first-class power at sea and on their coasts, then it must be at once admitted that these 70-pounder guns are as useless as a schoolboy's peashooter."—*Mechanics' Magazine.*

MILITARY ENGINEERING TRIAL OF GUN-COTTON.

A TRIAL of the powers of Gun-Cotton, as an explosive agent, has been conducted at Newcastle; and is described by the *Newcastle Chronicle* as an ordinary stockade, similar to what is commonly used in fortifications. It was composed of a double row of timber; the first consisting of six balks, each 10 ft. long by 12 in. or 14 in. square; the timber backing being formed of five balks 9 in. to 10 in. square. These balks were sunk about four feet into the ground, and firmly bedded. Two heavy logs, 7 ft. long by 14 in. square, were laid in front of the stockade to form a bridge on which to place the shell containing the gun-cotton. The timber was the best Memel. The shell was made at the Elswick Ordnance Works, and was of ¼th inch iron. It was 16 in. long by 12 in. in diameter, and in its general outline was similar in form to one of Sir William Armstrong's destructive shells. This cylinder contained 25 lb. of gun-cotton. To preclude the possibility of any accident occurring, no one was allowed to approach the stockade nearer than about 300 yards.

The cylinder was placed upon the bridge, and all being ready, the charge was ignited by the electric spark from a distance of 220 yards. The two centre timbers with their backing were blown clean away level with the ground, one large fragment having been hurled a distance of 130 yards; the other had been torn up into splinters. The posts left standing were forced outwards to an angle of 75 deg.; and a wide, gaping breach was left in the centre, through which an assailant could have easily entered. One of the timbers forming the bridge was torn to pieces by the force of the explosion; the other was comparatively uninjured, but was hurled a distance of about 40 yards, although its weight was estimated at a quarter of a ton. The force of the explosion had made a cavity in the ground in front of the stockade, and immediately beneath the bridge, fully half a foot in depth. Portions of the shell were scattered in all directions; and many of the spectators carried away pieces of the torn and twisted fragments as mementos of this exceedingly successful experiment. The post and rail fence of the Blyth and Tyne line, which runs near the spot, were cut through in one or two places without breaking the rails, as clean as if a man had done it with a chisel.

BLASTING POWER OF GUN-COTTON.

A NUMBER of interesting experiments have been made at Redhall Quarry, Slateford, near Edinburgh, to test the blasting power of the Gun-Cotton manufactured by Thomas Prentice and Co., Stowmarket, Suffolk, on a principle which admits of its being easily and properly placed in the holes formed for its reception. It is in the form of rope, is divided into lengths of about six inches, and varies in circumference according to the force required to be exerted. The centre of the twisted cotton rope is hollow, so as to admit of the fuse being thrust into it. The *modus operandi* of filling the chambers in the rock and firing the charge is simple, and requires but the exercise of ordinary care and precaution. The boring having been ascertained to be clear, the cotton is placed in the cavity piece by piece, and pressed home. Into the centre of the topmost "length" the fuse is inserted, and the hole is then filled to the top with sand, which is beaten down firm upon the cotton, heed being given not to injure the wires connecting the fuse with the galvanic battery.

ON GUN-COTTON.

MR. SCOTT RUSSELL has read to the British Association the Report of the Committee "On Gun-Cotton," from which it appears that the investigation is now placed in the hands of a Government Committee of scientific and practical men, who are engaged in a systematic course of experiments relating to the manufacture and keeping qualities of gun-cotton, and its use for artillery, small arms, and in engineering; and the committee of the association consider their work accomplished, as the investigation is now being made with greater facilities and means than could have been at their disposal. Mr. Scott Russell added some observations on the progress made since the last meeting in the application of gun-cotton. He stated that General Hay, of the Hythe School of Musketry, had constructed a new form of cartridge suited for the Whitworth rifle; that he had found that the use of gun-cotton was cleanly, and had not the disadvantage of fouling the gun; that it had much less recoil, although the effect was the same; that one-third of the weight of charge was the equivalent proportion, and that it did not heat the gun. The general had fired at a target with gun-cotton at 500 yards. Twelve successive shots were all placed in a space one foot wide by two feet high, and the value of the practice was measured by the fact that the mean radius of deviation from the centre was between nine and ten inches. Thus, therefore, the use of gun-cotton in musketry had been proved by English-made gun-cotton in English rifles by an English general, to perform all that the committee last year reported of Austrian gun-cotton on the faith of the Austrian General Lenk. The next application of gun-cotton made during the past year was to the driving of tunnels, shafts, and drifts in connexion with engineering work. It had been stated by the Committee that one-sixth of the

weight of charge of cotton was equal in blasting effect to gunpowder, and this had been proved in practice in a number of instances. At Wingerworth colliery, in driving a shaft through soft but solid rock, one-thirteenth of the weight of gun-cotton as compared to gunpowder, and in the slate quarries at Llanberis, at Allan Heads, one-seventh were required. At Allan Heads, in some lead mines, a tunnel was being driven seven miles long. The drift was 7 feet by 5 in the hardest limestone. Both ends were worked with gun-cotton fired by an electric battery. The great advantage experienced was that the air was not contaminated by smoke, and that the work could be carried on more rapidly. The next application of it had been to the detaching of large masses of rock. This had been tried in several places, and it was found that one pound of gun-cotton was able to detach from 30 to 60 tons weight of rock.

Mr. F. A. Abel added some remarks on the chemical condition and manufacture of Gun-Cotton. He stated that the manufacture of it was much safer and more uniform than that of gunpowder, and when made its stability was permanent and could be relied on. He believed the Report of the French chemists against its permanency was founded on experiments made with imperfectly manufactured material. Working with large quantities during the last twelve months, he was satisfied it did possess permanence, though he stated that under certain conditions of packing and exposure to too high a temperature a slight change did take place: this he believed arose from some foreign ingredients in the cotton.

NEW BLASTING POWDER.

Dr. Field, of Wilmington, Delaware, has compounded a new article, in two separate ingredients, which are mixed upon the spot just before using. The colour of these ingredients is different, one being black and the other white; they are non-combustible when separate, it being impossible to ignite or to detonate them; but equal parts of each being mechanically mixed, a new compound is formed, which is highly explosive, being in fact like any other powder, except that its specific gravity is greater, and its explosiveness or *strength* is much greater. A hole was drilled in the face of the quarry to a depth of four feet, and about eighteen inches of the powder being put in and tamped, it was fired in the usual way, and the explosion which followed was, all the workmen on the spot said, almost twice as effective as the ordinary powder would have been under the same circumstances. A test with some of the same material in a rifle also showed great strength as well as cleanliness, the lock or barrel showing no fouling whatever, after repeated discharges. The inventor claims that this gunpowder can be manufactured for sale at ten, twelve, sixteen, or eighteen cents per pound, the price of the article varying according to its strength. He also says that the ingredients being obtained, the powder can be ground up therefrom in an ordinary handmill in a quarry or on the field, no expensive machinery being needed. The simplicity of the means of its manufacture is the cause of its great cheapness. The non-explosive character of the component parts of the powder, when separated, is complete.

THE PRESSURE PRODUCED BY GUNPOWDER.

Professor Barnard, of Washington, has communicated to *Silliman's Journal* an article on the Pressure produced by burning Gunpowder in a cannon, in which he shows that the several experimenters differ very widely in their results; some stating the pressure at 7000 or 8000 lb. to the inch, and others at more than 200,000. Professor Barnard objects to all of the methods pursued by the different experimenters, and then remarks that we finally have an investigation which leaves nothing to desire—the investigation made by Messrs. Bunsen and Schischkoff. These eminent chemists analysed all of the substances resulting from the combustion of gunpowder, and calculated the pressure which they would exert if confined in the space occupied by the powder before it was burned; taking into account the specific heat of the several substances. Professor Barnard remarks that the powder was burned under the pressure of the atmosphere only, and expresses the opinion that the result would not be materially varied by that circumstance.

The best chemists in New York assert, on the other hand, that the burning of gunpowder under the pressure of the atmosphere only, affords no criterion whatever of the effects which would be produced by burning it behind a heavy shot in a cannon. By confining the powder, the heat would be far more intense, and this intense heat would cause an entirely different class of compounds to result from the combustion; thus destroying the foundation of the calculations.

Captain Rodman's plan of measuring the pressure of the gases resulting from the combustion of gunpowder in a cannon would seem, at first thought, to be unobjectionable. It consists in boring a hole through the wall of the gun, and screwing into this hole a hollow cylinder fitted with a solid piston, the outer end of the piston being of diamond form. When the gun is fired, the pressure of the gas drives the end of the piston into a sheet of pure copper to a depth varying with the pressure. The piston is afterwards forced into another piece of pure copper to the same depth by means of a press, the force of which may be measured, and the pressure of the gas is taken to be the same. It has been objected to Rodman's method that the inner end of the piston not being in contact with the powder, the gases would acquire a very high velocity in passing outward through the hole in the wall of the gun, and would strike the piston with a force far exceeding their pressure. It seems to us that there is force in this objection.

Captain Rodman found a pressure, in one instance, as high as 180,000 lb. to the square inch, and it has been objected by Mr.

Fisher, of New York, that such pressure would crumble the cannon to dust—the power of cast iron to resist a crushing strain seldom if ever exceeding 120,000 lb. to the square inch. The reply to this is, that the pressure does probably crush the iron within the scope of its influence; but, as the pressure is only momentary, it is exerted only upon the surface—causing an enlargement of the bore. Captain Rodman says that the pressure ordinarily produced in a cannon would blow the gun to pieces if it were not instantly relieved. *Mechanics' Magazine.*

EXPLOSION OF GUNPOWDER AT ERITH.

A TERRIFIC explosion of two gunpowder magazines, in Plumstead Marshes, occurred a little before seven in the morning of October 1st. The buildings were isolated on the banks of the Thames, and were used for storing and embarking only. Two barges lay in the stream, unloading powder brought from Faversham. A timber stage running out into the river, formed a roadway along which the barrels were conveyed to the magazine in barrows fitted with copper wheels. The work was proceeding satisfactorily when the explosions took place. Whether the work of destruction commenced in the barges or on shore, has not been determined. The boats disappeared as completely as though they had never existed. The second explosion following almost instantaneously on the first, effectually destroyed the magazines and the neighbouring cottages. Ten deaths are recorded, and serious injuries to many others. The effects of the explosions were in every way tremendous; they made themselves plainly felt through a radius of at least fifty miles. The consternation at Woolwich was excessive, windows and doors being blown in and many of the inhabitants suffering severe injuries in consequence, while at a distance the general impression existed that an earthquake had paid us a passing visit. The destruction had been so complete that there was little opportunity for scientific detail, and the direction of the destroying force did not appear to have varied sensibly from radial lines proceeding from the magazines as a centre. One exception was in the mansion of Sir Culling Eardley, which, although very near, suffered but little, a gentle hill intervening between it and the seat of the explosion, which had apparently exercised a protecting influence. The quantity of powder exploded was less than 1000 barrels, or short of 50 tons; the quantity that Purfleet stores is 52,000 barrels, or *two thousand three hundred tons.*

With respect to the primary cause of the catastrophe, the *Mechanics' Magazine* observes:—"As far as can be known, the powder was actually *in situ* in the barrels, and these last were headed up, and in every respect ready for transit. Now the staves of powder casks are commonly made of stout oak at least half an inch thick, put together so strongly with copper hoops, that the bursting of a cask, or the scattering of powder, does not take place once in a century. Within a magazine where matters are properly conducted, loose powder is never seen. There are tiers and tiers of handsome little casks or kegs, and that is all. Practically, the powder is shut up air-tight within the wood alone. In many cases, however, a still greater element of security has been introduced in the shape of a copper lining to the wood, that is to say, a close and well-made—albeit thin—copper cask is placed within each one of wood. This is intended to prevent the access of moisture, but it is obvious that it must equally keep out sparks. Provided, then, that the powder is properly headed up in the right kind of kegs, it is almost impossible to see how a spark can gain access to it. Even a strong flame would require some minutes to penetrate a half-inch oak stave; with the copper lining the time requisite to convey heat enough to the powder to explode it, would be considerably prolonged. List slippers and all the ordinary precautions usually observed, are intended to provide for the presence of loose powder. But in a magazine, loose powder should have no existence; provided the barrels are what they should be, no danger could possibly follow if a man pleased to strike a flint and steel for an hour over each keg. That kegs are not invariably as good as they ought to be, we admit; but the parsimony or negligence which permits the use of a bad or leaky keg is simply criminal, and the user deserves to be treated according to his acts. All things considered, we are disposed to regard powder properly stored in the best kegs as practically safe from all the dangers which mere sparks can occasion. There is no evidence to show that it was otherwise stored at Erith: we are therefore strongly inclined to believe that the cause of the primary explosion must be sought for within, and not without, the kegs.

MANUFACTURE OF GUNPOWDER.

MR. DRAYNE, of New Forest Powder Mills, Lyndhurst, has described, in the *Times* journal, an invention which he has introduced into the above mills, with the greatest success—by which means has been entirely prevented all danger in the manufacture of powder, after the powder has been removed from the grinding-mill. The most dangerous buildings, where explosions so frequently occur in establishments of this kind, are the press and packing-houses, and the dusting-house, in which many workmen are employed, whose lives must be sacrificed, if any one of the buildings should unfortunately explode.

Mr. Drayne maintains that powder can now be manufactured without incurring risk of life to those employed in making it. His invention does away entirely with the very dangerous buildings and their expensive machinery, and makes no dust in granulating the powder, which also lessens the danger by not returning the dust to be re-milled, re-pressed, and re-granulated; as it frequently occurs that grit, small stones, iron nails, and

other matter get into the dust, which will inevitably cause an explosion; and, as is seen by recent accidents, two or more lives must be sacrificed.

In his process, Mr. Drayne does away with all machinery of a very complicated and dangerous character; also with the presses that subject the powder to a very heavy pressure—a very dangerous operation. The process introduced into his establishment has reduced powder-making to a simple and perfect method. The powder is equal, if not superior, to that manufactured by other makers. Some manufacturers may say Mr. Drayne's grain does not look quite so angular as their own; his reply is, if the grain is less angular, it is quite as durable, quite as strong and clean, and equal in quality in every respect. The form of grain is superior, because the angles will not break off and form dust in the transit from place to place, as that made now by manufacturers is found to do.

THE CRYSTAL POINTER.

Mr. Edward Sang has read to the Royal Scottish Society of Arts, a "Notice of the Crystal Pointer, and of its application to Angular Instruments, to Rifle Shooting, and to Gunnery." The pointer is a prism, with two reflecting surfaces placed perpendicularly to each other, and including, with the two refracting surfaces, a four-sided solid. Through this the image is seen, not reversed, as with a mirror, but inverted, as with an astronomical telescope, and remains so, even though the prism be turned on its axis. In using it, it is turned towards the object to be aimed at; the operator looks through the glass, and having caught sight of the inverted image, brings it to agree with the object. By this instrument it is easy to take the altitude or azimuth of a star; and so to determine the latitude, the meridian, or the time. It is applied with great advantage as a rifle sight. It is fixed on a steel plate, moved in azimuth by means of a fine screw with a divided head; and that plate is secured to another moving vertically and abutting on an arc, divided to degrees and minutes, or marked for the divisions of the range. A very few trials suffice to render the picking up of the object easy; while the division into degrees and minutes enables us to record the effects of alterations in the charge of powder, the weight of the projectile, or the mode of loading. A peculiar convenience is, that if the smallest light be shown, we can at once aim at it, although the darkness be such that we cannot see the stock of the rifle.

SIGNALLING AT RIFLE PRACTICE.

Mr. David Bremner, of Edinburgh, has invented an apparatus for Signalling at Rifle Practice, to supersede the present primitive system of flag signalling, by which so many fatal accidents have at various times occurred. The two great objects aimed at by the invention are—first, the indicating on the target accurately and quickly the spot struck by each bullet; and second, affording to the marker perfect safety from accident. The first of these objects is accomplished by an apparatus which enables the marker almost instantaneously to cover with a disc the spot struck by each bullet. The disc, which is of the same diameter as the bull's-eye, is attached to a light pole or tin tube, of sufficient length to reach any part of the target; and this pole works in a narrow trench in front of, and running parallel to, the target. The pole, which passes through a guide, is made to slide up or down, by a cord and pulley arrangement, and is moved to the right or left by a cog-wheel which operates on the guide. At a distance of four yards, and immediately in front of the target, a small underground chamber is formed for the accommodation of the marker, who obtains access to his post by a few steps leading downward from the target. In the front of the chamber, and close to its roof, is a glazed loop-hole which commands a full view of the target, the ground in front of it being bevelled to allow of this. Beneath the loop-hole is the apparatus by which the disc is worked; a connexion between the two being established through a tunnel about two feet in diameter, and formed near the surface of the ground. As a means of protecting the apparatus from being injured maliciously, the discs placed behind the target may be taken down and laid in the marker's chamber; which, with the flap over the trench in front, may be securely locked up when practice is not going on.—*Mechanics' Magazine.*

STRUCTURE AND DEFENCE OF SHIPS OF WAR.

Admiral Sir Edward Belcher has read to the British Association a paper "On Improvements in the Defence of Ships of War." The author proposes to construct the ship on the customary plan of close iron ribs, but filling up the interstices between the iron with condensed teak. Constructing a vessel with 36 in. depth of rib, at the vulnerable portions to which shot can reach, which will probably involve 12 vertical feet of her side—say 8 feet below water and 4 feet above—we should then have a vessel of stronger framework than any now built, building, or contemplated. In lieu of teak the Admiral suggested paper or millboard as very efficacious. It is of importance to provide such a tonnage as shall, in the case of ships of the *Warrior* class, be capable of floating the contemplated armament, independent of the forward and after compartments. The first object will be the fortification of the sides, or contour of the oval form of battery up to the lines of rolling, by such a disposition of iron framing as may effectually withstand the heaviest missile discharged from the heaviest gun with impunity.

On a previous occasion Sir E. Belcher said, he had alluded to paper as an opposing medium. In 1816 at Algiers a ream of

foolscap, end on, resisted a 68-pound shot from a 27 feet gun, at 76 yards; and in 1854 he proposed to the Admiralty to construct moveable battery rafts of brown paper, but the design was not carried out. Lately he learnt from a newspaper that, ten years after his proposal, it was found that paper of 1 in. thickness was fired at and not quite penetrated, while a similar shot went quite through 10 in. of good oak. In conclusion he would observe that condensed millboard weighed less than oak or teak, and interposed in the manner he had suggested, might form a target which would set even *Big Will* at defiance.

The Chairman of the Section said, he had himself always felt considerable difficulty in all the suggestions made from time to time for building ships of war, where iron and wood were used, on both of which the strength of the ship itself was made to depend. It appeared to him, apart from the different modes of construction which had been suggested from time to time, that what they ought to aim at and secure if they could, was to build a ship wholly of iron, so that the ship, if stripped of all its other coating, would still be a water-tight ship, capable of navigating; and in this way they would, of course, have a perfect structure. Without that he did not see how they were to escape the dry-rot, and so on. Of course, that would be an objection to the mode proposed by Admiral Belcher, as it was pretty much to all the modes hitherto adopted. To make ships quite invulnerable would only be to make them unmanageable at sea.

Capt. Wheatley R.N., has also read to the Association a paper on this subject, in which he said:—"The result of the experiments at Shoeburyness has publicly proclaimed that the 13 in. gun is the only gun to be thoroughly depended on to act against iron plates. It must be, therefore, universally adopted as the chief naval gun. It may, however, be modified by the introduction of gun-cotton. As yet we hear of no preparations for its adoption in our navy, but as we have mounted up from the 8 in. to the 9 in. and from the 9 to the 10½, so, I trust, we shall shortly come to the 13 in." Capt. Wheatley next proceeded to submit a system calculated to mitigate the great evil which would be caused by fragments of iron and splinters of wood, as shown by the experiments at Shoeburyness.

Part of this system is to provide screens of oiled south-wester canvas tied up between the beams in the wings, and having a piece of heavy wire rope at the bottom. When let down immediately the shot has struck, a bag of wood shavings is to be forced into the gap, covered by a plank, and shored up from the inner side of the wing. This will only stop the main rush of the water; a great deal will still flow through the irregular crevices. These it is proposed to stop by plastering the canvas to the side with hydraulic cement, which is said to become fixed under water in a quarter of an hour.

STRAIN OF SHIPS.

PROFESSOR RANKINE has read to the British Association a paper on some of the Strains of Ships, of which the following is an abstract:—In previous scientific investigations respecting the strains which ships have to bear, it has been usual to suppose the ship balanced on a point of rock, or supported at the ends on two rocks. The strains which would thus be produced are far more severe than that which would have to be borne by a ship afloat. The author computes the most severe straining action which can act on a ship afloat—viz., that which takes place when she is supported amidships on a wave-crest, and dry at the ends; and he finds that the bending action cannot exceed that due to the weight of the ship with a leverage of 1-20th of her length, and that the racking action cannot exceed about 16-100ths of her weight. Applying those results to two remarkably good examples of ships of 2680 tons displacement, one of iron and the other of wood, described by Mr. John Vernon in a paper read to the Institution of Mechanical Engineers in 1863, he finds the following values of the greatest stress of different kinds created on the material of the ship:—In the iron ship, tension 3·98 tons per square inch, thrust 2·35, racking stress 0·975. It follows that in the iron ship the factor of safety against bending is between 5 and 6, agreeing exactly with the best practice of engineers, and that there is a great surplus of strength against racking. In the wooden ship, tension 0·375 ton per square inch, and thrust 0·293. Here the factor of safety is between 10 and 15, which is also agreeable to good practice in carpentry. As for the racking action, the iron diagonal braces required by Lloyd's rules would be sufficient to bear one-third of it, only leaving the rest to be borne by the friction and adhesion at the beams of the planking.

A NEW COMBINATION SHIP.

THERE has been launched from Mr. Charles Langley's Commercial Dock, Rotherhithe, an Alabama-rigged patent Combination Ship, of 650 tons burden, intended for the East India and China trade. She was built from the design and under the superintendence of S. H. Harrington and Co., the naval architects, of Leadenhall-street; and the Admiralty have contracted with Mr. Langley, to build an ironclad vessel of war, on the same principle. The mode of construction is this:—The frames of the vessels are constructed entirely of angle iron of the same weight as that used in building iron ships of a similar tonnage. Each frame is then riveted to a horizontal keel, stem, and stern-plate broad enough to fasten the starboard strake to. A middle line keel-plate is then riveted between the upper and lower horizontal keel-plates, by means of angle-irons running longitudinally the whole length of the ship, forming therewith a strong girder of a similar construction to those used in railway bridges. The half-floor plates are riveted to the middle line keelson, between dou-

bling clips of angle iron, and carried up in the usual way to the turn of the bilge, and the reversed frames are riveted on across the floor heads and carried up to the stringer plates. The first planking consists wholly of teak, and is fastened to the frames by galvanized nut and screw bolts from keel to gunwale. The wood keel is also brought on the iron horizontal keel-plate, and fastened to it by means of iron screw bolts from inside. The garboards are then rabbeted in and fastened through the iron keel-plate with galvanized iron nut and screw bolts. This first skin is 2½ in. thick, and the seams are fitted close and double fastened to the frames throughout. Diagonal straps of iron ½ by ⅛ in. are then let in, and on this skin crossed in squares of about 6 feet, fastened through frames when they cross, and carried from keel to gunwale. A suitable composition of chunam is then used, and the outer skin of 2½ in. rock elm brought on to the turn of the bilge. Thence upwards 2½ in. teak is used. Each plank is fitted to overlap the inner seams, and then fastened with yellow metal clench bolts to the inner skin, all the holes being carefully bored free from iron frames or straps. By this means the planking of the vessels is tied together vertically as well as longitudinally; no copper bolts or metal sheathing are in contact with iron, and the vessel is felted and sheathed with copper in the ordinary way. The apparent advantage of this system is that there are no through seams, no risk of galvanic action, great longitudinal strength; and increased buoyancy, and capacity, over vessels built wholly of iron.—*Mechanics' Magazine.*

THE "ROYAL SOVEREIGN" TURRET SHIP-OF-WAR.

In the *Year-Book of Facts*, 1864, pp. 44-48, we gave the details of the conversion of the *Royal Sovereign* into a turret-ship. We now report the first result of testing, in July last, Captain Cowper Coles's principle of working monster ordnance on board ship by means of revolving platforms protected by cylindrical armour. It was an important point to test the ship under steam off the land, for on her first preliminary gun outside Portsmouth harbour the steam-pipes of two of her boilers gave way at their junction in the stop-valve boxes; and, with this object in view, Captain Osborn caused the guns to be fired in every position the ship assumed under the influence of her engines and the motion given to her by the wind and sea; when the communications between the steam-pipe and boilers remained in their normal condition, thus proving that the expansion joints which had been applied in Portsmouth Dockyard were fully equal to the service for which they were fitted, and would prevent any recurrence of a similar accident to the one referred to. The low angles of 5 deg. to which the ship only reached in her rolling motion prevented Captain Osborn and Captain Coles from testing the working of the turrets and guns in as severe a manner as they wished, but no perceptible difference in the revolving of the turrets or the working of the guns was noticed by the

men employed. In the firing, two rounds were first used in scaling the guns, and afterwards 93 rounds were fired from them with solid cast-iron shot and 35 lb. and 40 lb. charges, according to the elevation of the guns. There was not the slightest hitch throughout. The tables on which the turrets and guns stand revolved as freely, and the guns worked as easily and controllably, as during the two days' previous practice in St. Helen's Roads; there was also the same absence of concussion or smoke inside the turrets or on the lower deck. The *Royal Sovereign* fired in the above experiments 20 shots per gun from her five guns, and at different angles and degrees of elevation, the highest elevation being 18 deg.—an extent of elevation which can be attained by the guns of no other ship in her Majesty's navy, whether mounted on the broadside or pivoted on the upper deck.

The *Royal Sovereign* must be viewed from three distinct positions, it being necessary that this part of the question should be thoroughly understood in order that no erroneous impressions may take their hold on the public mind. These three positions are:—1, The hull of the ship; 2, the turrets and their motive power; 3, the guns. For the first and third, the Admiralty and War Department are alone responsible. For the second, Captain Coles alone has to answer. We have said enough to prove that Captain Coles's part in the work has been well and satisfactorily performed. With regard to the ship's hull and her guns, a little more remains to be said. In the first place, whatever her behaviour may eventually prove to be at sea, the *Royal Sovereign* is, after all, but an adapted means of floating turrets and guns so as to test the practicability of the system afloat. The hull undoubtedly draws too much water—that is, swims too deeply—to be of service in shallow waters; it has too much breadth, and exposes an unnecessary area of upper-deck planking to a plunging fire; but these and other objections which might be urged against the hull of the *Royal Sovereign* are matters which concern only the Admiralty and the public, but not Captain Coles.

The ship's guns are a more serious matter to deal with. The four turret-guns of the *Royal Sovereign* each weigh 12 tons, and have each a bore the diameter of which is 10½ inches. They are "coil"-built, but are simply smooth-bore guns, throwing a spherical cast-iron shot of 150 lb. with 35 lb. of powder as a "full" charge, or with 40 lb. of powder as a "distant" charge. Now, it is evident that from this 12-ton gun, with its 10½ in. diameter of bore, but a miserable return is got with a 150 lb. cast-iron shot. The fact is, the guns of the *Royal Sovereign* should be made by some simple mode of rifling to throw 300 lb. cast-iron shell for any engagement with wooden ships, and steel shot and shell of the same weight for the benefit of ironclads. It is asserted, however, that the *Royal Sovereign's* guns will only stand as smooth-bores, and that any attempt to rifle them can only end in their destruction. This assertion reduces the question of the *Royal Sovereign's* efficiency to a very narrow compass. If she has to wait for her rifled 300-

pounders (or 600-pounders, as the case may be) to be manufactured, then the ship should be at once supplied with steel shot to some extent, however small, in order to render her present armament of smooth-bore guns of some use against the iron coat of an adversary.—*Abridged from the Times.*

VENTILATION OF SHIPS.

An important part of Dr. Edmonds' Ventilating Apparatus has been fitted to the *Royal Sovereign* cupola-ship, in which, by a simple arrangement, from 300 to 350 channels actually existing in every ship have been made available for the ventilation of the bilges and timber spaces. This is done by converting the latter into branch channels of one long air-shaft, constructed along each side of the ship. Through this air-trap a draught is created by communicating it into the funnel or ash-pit in steam-ships, or into ordinary ventilators in sailing-ships,—in either case revolving fans, worked by hand or machinery, may be used in connection with this system, if an extraordinary amount of ventilation is required; and from its diffused action injurious draughts, which are inseparable from all other plans in use, are entirely avoided. Shipowners are interested in the success of this system, as it promises to prevent dry rot by the free circulation of air which it creates through the whole framework of the ship. But it serves another equally important object,—that of the removal of all the foul smells usually prevailing between decks, which are engendered by dampness in the timber spaces, and decaying matter lodged in them. This is a very important result to obtain, particularly in troop and emigrant ships, as these are often causes of disease in hot climates. To perfect the ventilation deep air channels are provided, which form part of the deck itself, and act immediately below it, but even without these a very efficient ventilation can be obtained. In the *Royal Sovereign* the efficacy of the plan has been already tested, so far as her present state of equipment admits of it; a very slight increase of temperature in the funnel being sufficient to draw a current of air through the air-shafts, and necessarily through the whole framework of the ship, which passing into the funnel is carried high into the open air.—*Mechanics' Magazine.*

THE "ENTERPRISE" MINIATURE IRON-CLAD.

Mr. Reed, Chief Constructor to the Navy, has succeeded in building and coating with 4½-inch armour a wooden sloop no larger than the collier barks which crowd the pool below London-bridge. The difficulty thus overcome is very much greater than it seems, as a few words will show. As soon as the necessity for armour-ships was admitted in England, after the launch of *La Gloire*, it was evident that a certain height of plating, varying from 16 ft. to 21 ft., would be necessary in most classes of vessels; and that if this protection was to extend the whole length of the hull, then seaworthiness and swiftness could only be secured in vessels of the largest description. But, by shortening the battery and confining the guns to the centre of the ship, the extraordinary weights and dimensions could be reduced, and such ease given to the stem and stern as would add greatly to the buoyancy of the entire hull. As these ships, however, would have to endure heavy weather, and, in case of war, very heavy fighting too, it was necessary to consider what their condition would be with their unplated ends water-logged, and to make the length of the protected part in the centre sufficient to bear up the stem and stern when their own buoyancy was destroyed. Upon this principle the *Warrior, Black Prince, Defence*, and *Resistance* were designed; but the two latter, though more than double the tonnage of Nelson's *Victory*, were found to be the smallest which would satisfy these conditions. If, therefore, smaller seagoing vessels were to receive the protection of iron armour, it was evident that even the system, partial as it was, must be given up. The iron wall required for the safety of the guns and gunners must be reduced in length, and the safety of the lower part of the hull near the water-line provided for by a simple armour-belt from five to seven feet wide, so disposed as to protect the machinery and all beneath it; the high or gun wall of the battery being shortened by only containing the smallest number of guns, but all of the very heaviest calibre used in war. The attempt to fulfil all these conflicting conditions has been made by Mr. Reed in the *Enterprise*, the smallest class of seagoing vessels of war, the sloop plated with the same armour as that which covers the *Warrior*—4½ in. This vessel is of only 950 tons builders' measurement, and was intended to carry 17 32-pounder guns. This number of guns was at once reduced to four, and the number of the crew from 165 to 100. This great reduction in the number of guns does not necessarily imply a reduction in the weight of metal thrown in a broadside, as the guns will be very much larger. The guns actually to be mounted in this ship are 110-pounders, throwing a broadside of 220 lb.; but guns may be carried which would equal in weight of metal thrown the original broadside of the 17-gun sloop, and would, of course, be far more destructive in their action. But, in thus transforming a small 17-gun wooden sloop into a 4-gun iron-cased sloop, a sacrifice of speed was inevitable. The weight of propelling machinery was reduced 25 tons, while the weight of ship to be propelled was increased 200 tons. The speed lost will be from half a knot to a knot. The speed of the *Enterprise* under steam alone will be, it is hoped, between 9 and 9½ knots, or a little over 10½ miles per hour.

In order still further to provide for efficient ventilation, and particularly with a view to the preservation of the frame of the ship, a passage is left along the wings on each side and beneath the flooring of the several divisions. There is thus scarcely a foot of the frame of the ship which is not in direct communication with the central passage, and acted upon either by the draught of the furnaces or by the Schiele's fan. Directly below the battery, and

over the magazine and shell-room, is a large platform to be used as a cockpit, communicating by a covered passage through the engine-room with an after cockpit and dispensary.

The dimensions of this miniature iron-clad are only 189 feet long by 36 feet wide, her engines are to be of 160 horse-power, and her speed is estimated at nine knots. Though an experimental vessel, the success of the *Enterprise* has been secured by the admirable seagoing performance of the *Research*, another ship of much the same class, only 200 tons larger, which made a successful passage round from Milford to the Thames. This little corvette carries five inches of armour, and in the run round to the river, though the weather was very rough, she often steamed 10¼ knots, rolled easily and not deeply, turned a full circle in 4 min. 18 sec. in five times her own length; is well ventilated, buoyant, and when equipped for sea, will draw only 14 feet of water.—*Times, abridged.*

NEW IRON-CLAD FRIGATES.

THE Admiralty, adopting the plans of Mr. Reed, the new Chief Constructor to the Navy, decided to let him carry them out after his own manner; and certain new iron-clads, of all sizes, and to answer various purposes, are now building, and some built. These vessels are the *Enterprise*, sloop, four guns, 990 tons, builders' measurement, and 160 horse-power; the *Research*, sloop, 1250 tons, seven guns, and 200 horse-power; the *Favourite*, corvette, 2372 tons, eight guns, and 400 horse-power; the *Pallas*, 2372 tons, five guns, and 600 horse-power; the *Zealous*, 3715 tons, 16 guns, and 800 horse-power; the *Lord Clyde* and the *Lord Warden*, sister ships, each 4067 tons, 32 guns, and 1000 horse-power; and the *Bellerophon*, 4246 tons, 12 guns, and 1000 horse-power. Of these eight ships the *Enterprise* was originally designed as a wooden sloop, named the *Circassian*; so also were the *Research*, *Favourite*, and *Zealous* respectively a wooden sloop, corvette, and frigate actually in frame, which Mr. Reed had to adapt as he best could; the forms of these, therefore, he contends are not such as he entirely approves for iron-going vessels, especially in the shape of the bows, which are much too fine *beneath* not to render them liable to pitch. The *Lord Warden* and the *Lord Clyde*, the *Pallas* and the *Bellerophon*, are entirely from stem to stern of Mr. Reed's design. The two former are improvements on vessels of the *Royal Oak* class; the two latter are quite new, both in principle of construction and in the purpose they are intended to fulfil, and it is of them especially that we wish to speak as the finest samples of our new iron-clads. The *Bellerophon* is in point of strength intended to be a monster among these monsters—to be, in fact, as terrible an assailant to iron-clads as an iron-clad would be to wooden ships. The usual practice of the Admiralty has been to build their iron frigates first, and then test their strength in targets afterwards; but the converse of this rule was adopted with the *Bellerophon*. When her target was tried at Shoeburyness, the experiment proved, as far as the heaviest rounds of shot and shell could prove it, that a ship built on such a plan would be absolutely invulnerable to any artillery known to exist. Her success on this important point being thus guaranteed, the work of building her was at once begun at Chatham. The object with which this vessel is designed is to be to a fleet of iron-clads what a fox-terrier is to a pack of hounds—a vessel of such strength and speed and tremendous weight of guns as in case of an enemy's iron fleet running into port she can follow them with impunity, and at long range fight them at their moorings, till she either drives them ashore or drives them out to sea. As Mr. Penn undertakes that her speed shall equal her strength, there seems to be little doubt but that, with her impenetrable sides and her armament of ten 300-pounders and two 600-pounders, the *Bellerophon* will be the most formidable seagoing frigate the world has seen. The length of this vessel is 300 ft., and her breadth 56 ft.; her tonnage 4246 tons, her displacement 7053 tons; and though carrying the heaviest armour and armament ever sent afloat, her draught will be only 21 ft. forward and 26 ft. aft, less than the draught of ordinary two-deckers. The height of her lowest portsill from the water is 9½ ft., the distance between the guns 15 ft., and the height between decks 7 ft. Her midship section is smaller than that of the *Warrior*, and to that extent, therefore, she will be easier to steam and sail; she is to have four masts—only the first square-rigged, the three others carrying immense fore and aft sails, a rig from which the French have got such admirable results with their iron frigates under canvas. In the engines of the *Bellerophon* it is hoped to effect a great improvement as regards the consumption of coal. The *Black Prince*, which is now probably the fastest ocean steamer afloat, burns at the rate of 4½ lb. of coal per indicated horse-power per hour; and on her trial-trip, with her screw going 54 revolutions, she did 15½ knots an hour, and can be depended on at sea to average as high as 13. In the *Bellerophon*, however, it is hoped by working with superheated steam surface, condensation and expansion, to reduce the consumption of coal to 2¼ lb. per indicated horse-power per hour. If this great result be effected, she will carry 16 days' fuel instead of nine; and if, as is expected, Mr. Penn can get 65 or more revolutions out of her engines, she can be depended on at sea to average 15 knots, or nearly 18 miles, an hour.

The ribs and framing of the *Bellerophon* will be much the same as those of the other iron frigates, with the exception that the stringer plates and diagonal bracings will all be of steel—that is to say, of less than half the weight, and more than four times the strength, of the present system of wrought-iron fastenings. Steel is to be adopted in the frame of this new frigate; and Mr. Reed estimates that by this method, and while making the hull infinitely stronger, he will save in weight two or three hundred tons, which can be infinitely better bestowed in increasing the thickness of the armour-plating. It is the first time that steel has ever been

used in these vessels. If we hope to get beyond our present manufacturing standard, we must turn our attention to producing and utilizing iron in one of the highest stages of development in which it is known to us—in the form of tough soft steel.

The armour of the *Bellerophon* is to be no less than 6 in. thick, and this is to rest on 10 in. of solid teak beams. This outer protection is quite formidable enough, but what it protects is of its kind quite as strong in proportion. The inner skin consists of two plates, each of ¾ in. thickness, with a stout layer of painted canvas between to deaden concussion. Outside this skin come angle-iron stringers of the tough steel we have already spoken of. These angle-iron stringers in any metal would be of immense strength, and project from the inner skin 9½ in. and 10 in. alternately. Thus they form so many longitudinal shelves of the depth we have mentioned, which run from stem to stern of the ship, two under each row of plates; and in these the teak beams are laid, the longitudinal layers of the angle-irons keeping the beams up to their work, and preventing their lateral splintering; while they also support the plates with their edges, and prevent their bending in unfairly on the teak.

It is almost needless to say that the *Bellerophon* is not thus coated from end to end and over all, with this tremendous armour. All Mr. Reed's skill would fail to make a frigate seaworthy with such a mass of metal to uphold. In the centre and for 90 feet of her broadside she is thus protected, from 5 feet below the water-line to the level of the upper deck. In this space are her guns, five 300-pounders, with one 600-pounder at each side. For the rest of her length there is only a belt of this massive armour, which goes to the same depth beneath the sea, to six feet above it, so that she cannot be hit in any part where the water could enter. The two ends above this belt are built of tough light plates of steel: here the crew and officers will live in times of peace, and here there can be as many portholes to the cabins and ventilating spaces as in an ordinary passenger steamer. In action, of course, all the officers and crew would be in the battery or below the line of the armour, six feet above the water-mark, leaving enemies' shot to pass in and out of the rest of the vessel above them as they might happen to strike. No harm could be done if this part was riddled through and through in all directions; as at six feet above the sea, scarcely any water could enter even in the roughest weather, and with the holes left unplugged. As a matter of course, all the engines and magazines are well under cover of the plating; and the great length of the stem and stern from the centre battery being thus lightened to the utmost of superincumbent weight, will render the whole ship, it is calculated, as seaworthy in the heaviest weather as a Cunard mail packet. The cost of this most formidable of all our future iron-clads is estimated at 90,000*l*. less than that of the *Warrior*.

The *Pallas* is another special vessel by Mr. Reed, who has designed it for great speed, both in sailing and steaming, to carry only five guns, all 100-pounders, of the longest range—a bow chaser forward and two at each side. Her length is 225 ft., her breadth 50 ft. and her tonnage 2372, with a draught of water 18 ft. forward and as much as 24 ft. aft, in order to enable her to turn very quickly. She is of wood, but entirely coated from end to end with 4½ in. armour. She is to have a screw of great diameter. Her engines are to be of 600 horse-power, and on the economical principle carried out with such marked success by Messrs. Humphreys and Tennent on board of the *Mooltan* and other of the Peninsular and Oriental Company's vessels. Engined on this principle, she is expected and ought to be able to carry coals enough for sixteen days' hard steaming; and with her huge fore and aft sails (only the foremost being square-rigged) should have but little occasion to steam at all except in chase. Fourteen knots per hour seagoing speed is anticipated from this new frigate; and at this rate, and with her large crew and heavy guns, she undoubtedly ought to be able to sweep the seas of any number of war-vessels less strongly plated, less heavily armed and manned, and less speedy than herself.—*Abridged from the Times.*

TWIN SCREWS.

The trial of the *Rattlesnake*, twin-screw steamship, has been attended with the most complete success, and was a further illustration of the value of the twin-screw system, which will undoubtedly prove a most valuable auxiliary for war purposes, and especially so for all ships whose armament is carried on the broadside; the twin-screws giving vessels a power of revolving nearly, if not quite, equal to that of the turret or cupola. In addition to this one great advantage in its application to ships of war, the twin-screw principle also enables any vessel, whether engaged in the pursuit of war or commerce, to carry a great weight with large engine-power, at a lighter draught of water, than can be attained under any other arrangement of a ship's propelling power. It is the established possession of these points of superiority over the single screw that has led to its large adoption in the mercantile marine of this and other countries; in the ships of war of Russia, America, Italy, and France; and at length into our own Royal navy, in the construction of two vessels designed by Mr. Reed—the *Viper*, iron, and iron-plated, 733 and 167 horse-power of engines, built for the Admiralty by Messrs. J. and W. Dudgeon, of Cubitt-town; and the *Vixen*, iron and wood built, and iron-plated, 754 tons and 160 horse-power, built by Mr. Lungley, at Deptford-green. The *Rattlesnake* is a vessel 200 feet in length, iron-built, with a beam of 25 feet, and a depth of hold 13½ feet, and her tonnage, builders' measurement, of 615. She is fitted with engines of 200-horse power, collectively, with a diameter of cylinders of 34 in. and a 21 in. stroke, the screws having a diameter of 9 feet and a pitch of 17 ft. 6 in. She is a fine clipper-

looking craft, with two masts, schooner-rigged, and two funnels; and is, in fact, almost a copy of the now celebrated *Talahassee*, excepting that the *Rattlesnake* is fitted with a poop and a deck-house amidships, which the *Talahassee* was not built with. Messrs. John and W. Dudgeon, of Cubitt-town yard, and the Sun engineering works, are the builders of both the ship's hull and her engines. In the first trial, the distance between the Nore and the Mouse light vessels was accomplished in 26 minutes; and this gave the *Rattlesnake* the extraordinary speed of over 17 knots—extraordinary indeed if the proportionate power of her engines to her tonnage is considered. It was merely a trial of engines and speed of the ship, all experiments in making circles and revolving under steam being unnecessary, owing to the results gained on former trials of vessels fitted with twin screws. Although, however, no official trial was made of the *Rattlesnake's* power in this respect, enough was done to satisfy the most sceptical that she possessed the same revolving powers and quickness of motion that her sister had possessed before her, and that no vessel fitted with a single screw could ever approach. The sister vessel to the *Rattlesnake* has run the distances each way between Wilmington and Bermuda in 53 and 54 hours respectively, absolute time. As it is 730 miles between the two ports, this gives 1460 miles for 107 hours' steaming. The engines of the *Rattlesnake* worked very satisfactorily throughout the day's trial. Their revolutions averaged 120; steam pressure, 28 lb.; vacuum, 25. The twin screw has been found equally successful at sea.

THE STEAM RAMS, "SCORPION" AND "WYVERN."

THE following is the description of these vessels (sister ships) and their armament:—Each has length on water-line, 224 ft.; beam, 42 ft. 6 in.; depth, 20 ft.; measurement, about 1890 tons. Their engines also manufactured by Messrs. Laird Brothers, are 350 horse-power, on the horizontal principle, with double piston rods. The cylinders are 56 in. long, with a 3 ft. stroke. There are four distinct boilers, which may be used separately or together, and 16 furnaces. The whole of the machinery is below the water-line. The ordinary hull is of iron, of extra strength; over this is a coating of 10 in. of teak and armour-plates 4½ in. thick, nearly the whole length of the side, but tapering in thickness at bow and stern. The stem curves outwards five feet below the water-line; and, being formed of massive wrought-iron, forms a ram of immense penetrating force. This prow, as regards the propulsion of the vessel through the water, really forms part of the hull. The stern is shaped with the view of protecting the screw propeller and glancing off shots. The whole arrangements display great combination of strength. There are two turrets, the greater portion of which is below the main deck, carrying two 12-ton guns each. The plating of the turrets is 5½ in. thick. On the trial the *Scorpion*, with 200 tons of coal on board, drew 13 ft. forward and 14 ft. 9 in. aft. Her steering qualities were found to be admirable, and she made a complete circle in an average time of five minutes. The speed obtained in running the measured space, 0·906 of a knot, between the Queen's channel Fairway buoy and the Victoria channel Fairway buoy averaged 10·490 knots. The starting gear of the engines is worked by a small engine, instead of by hand, which gives the engineers a great command over them. In reversing, the plan was found to work admirably.—*Mechanics' Magazine.*

COATING OF SHIPS WITH GLASS.

BY direction of the Admiralty, experiments, which are stated to be highly satisfactory, have been carried out at Woolwich dockyard to ascertain the practicability of coating the bottom of iron ships on a plan invented by Mr. Leatch: this consists in coating the iron surface with gutta-percha or other cement, and on this soft material fastening sheets of glass about a quarter of an inch thick. The glass is previously bent to the shape of the ship, and pierced for the reception of the screw or bolts; the apertures being lined with a soft adhesive composition, which prevents the fastenings from coming into immediate contact with the glass.

SUBMARINE BOAT.

A LETTER from Rochefort states that a Submarine Boat has been built in that port: it is shaped like a fish, of which the back, rather convex, serves as a deck, but without bulwarks. The stern is slightly rounded, and the bow is terminated by a spur, partly concealed under water. This boat is traversed length-ways by a large pipe laid on the deck. It is by this pipe, which is pierced with small holes, that the water enters to sink the boat. It is likewise by this pipe that the air enters to lighten the boat and bring it up to the surface. The vessel is propelled by means of a screw, set in motion by compressed air. It is said that the crew of the boat may remain four hours under water. This boat, *Plongeur*, does not draw more than 8 ft. of water; her engine is of 80 horse-power, steam is replaced by compressed air, and her crew of twelve men are stated to be protected from all danger. The *Plongeur* is intended to be a formidable engine of destruction. Her spur is formed like a tube, and an incendiary shell may be placed in it. Should an enemy's fleet be at anchor the *Plongeur* will drive her spur into the nearest ship and then retreat, unrolling at the same time a metallic wire. When at a safe distance an electric spark will cause the complete explosion of the enemy's ship.

In the *Mechanics' Magazine* we find the following report of an experiment made to test the above vessel at Rochefort:—"The boat was stated to be so constructed as to admit of being almost instantly submerged by compressed air and a peculiar apparatus with which it was provided. The only part that remains visible

is a small tower, whence the commander may observe the position and motions of the ship to be attacked, and direct his men which way to steer in order to strike her hull with the formidable spur which constitutes the chief means of attack of the new contrivance. The experiments, however, were not satisfactory: more than an hour elapsed before the new vessel got under water with an indolent sort of see-saw motion. She slowly performed the whole distance from one end of the port to the other, and then veered round to return. On nearing the starting-point she very nearly ran foul of one of the vessels in the port, whereby the power of her spur would have been tested in rather an unexpected and unwelcome manner."

NEW TORPEDO BOAT.

THE *New York Herald* speaks of a new Torpedo Boat recently invented by chief engineer Wood, U.S.N. This vessel is designed to explode a torpedo in contact with a ship's bottom, and is an entirely new conception. She is built of wood, is 75 ft. in length, 20 ft. beam, and 7 ft. depth of hold. She is constructed in the most substantial manner, with heavy beams supported by hanging knees, securely bolted and fastened. The deck is crowned about 2 ft. fore and aft, and about as much athwart ships, and this will be covered with a thickness of iron armour sufficiently strong to make it shot and shell proof. The vessel will sit very low in the water under any circumstances; when not actively employed she will float some 20 odd inches above the surface; but when approaching a vessel to destroy her or engage in blowing up obstructions, only the crown of her deck will be above water. There are but three objects above the decks—viz., pilot-house, smoke-stack, and ventilator. These only show a few inches at the most. These articles are perfectly shot-proof, and their openings are protected in the most secure manner.

The novelty of the vessel is not seen until a visit is made below the deck. Away aft is placed the engine, with a cylinder of 18 in. in diameter, and 18 in. of stroke of piston. This engine works a screw of a size capable of forcing the vessel through the water at the rate of say 12 miles per hour. Next comes the boiler, which furnishes steam for the main engine as well as for the auxiliary engines, which work the submerging pumps, and the mechanism by which the torpedo arm places the torpedo beneath the ship. Everything connected with these machines is of the most simple and durable kind, and not liable to get out of order. Forward of the boiler is the steering wheel, located beneath the pilot-house, and then the torpedo machine.

NEW SOUNDING APPARATUS.

A NEW marine Sounding Apparatus has been invented by M. Goüezel. A great objection to that at present employed is that currents in the water cause the line of suspension to be bent, and so the apparent depth, judged of by the length of line employed, is much greater than the real depth. The purpose to which the new Sounder is intended to be applied is for the construction of a chart of the bottom of the ocean, which would be of immense service in the laying of telegraphic cables; and, apart from such uses, the possession of such a map would be of great scientific interest. In the improved apparatus the suspension line is altogether dispensed with; a rod of iron, furnished with nippers at the extremity, supports a cylindrical weight capable of being detached from the rod; above the weight a float of hollow metal is fixed. On striking the bottom of the water, the weight is detached, and the remainder floats to the surface; a small clock enclosed in the apparatus is so arranged as to stop by the concussion, so that the time of descent can be estimated; a bell is also attached; an easily visible object is fixed above the whole, to avoid any difficulty in finding the apparatus after its arrival at the surface. The advantages of this apparatus for the purposes to which it is destined are so apparent that comment is unnecessary: close approximation to the real depth of the water at various parts of the ocean, with much more rapidity than with the old method, will now be obtainable, the friction of the line in the water retarding the descent to an immense extent.

NAVAL SIGNALLING.

SOME interesting experiments on Naval Signalling have been conducted under the auspices of the Lords of the Admiralty with perfect success. The means employed are principally the Electric and Lime Lights. The entire system of transmitting the signals by day and by night is available under all circumstances, and is expressed by jets of steam, revolving shutters, a collapsing cone or disc by day; by one bright light by night, and by a fog-horn or steam-whistle in a fog. With these means the following results have been obtained:—

The new code may be said to be based upon the Morse Telegraph, the short and long dashes in the printing of which are represented by Captain Bolton and Commander Colomb, to whom the nation is indebted for the development of the system, by the time the jets of steam, cone, or disc, or shutters, are exhibited by day; the time the light is flashed in by night, and the duration of the sound emitted by the steam-whistle or fog-horn in a fog. For exhibiting the light or cone on board ship, Commander Colomb makes the duration of the signal dependent upon a mechanical arrangement of his own invention, which leaves nothing to the judgment alone of the signalman, and makes use only of numerals, which are thus applicable to the present navy signal-books. Captain Bolton has also introduced a lime light field apparatus, which is supplied by the War Department to our Royal Engineers at a cost of about 85*l*. only.

DABOLL'S LARGE FOG TRUMPET.

MR. DABOLL, of New York, the inventor of fog whistles, has received an order from the English Government to build and furnish a larger and more powerful signal than he had hitherto made. It will consist of two twenty-four inch caloric engines, placed side by side upon a platform or bedplate of cast iron. Upon the same platform will be two air-tanks or receivers, into which will be condensed the air for blowing the trumpet. But one engine will be made use of at a time, the other being a reserve in case of accident, and either can be fired up in about half an hour. The automatic arrangement by which the trumpet is blown and operated can readily be changed from one engine to the other. The trumpet is intended to revolve half way round and back in about a minute, and blow its blasts as it moves around. This apparatus is specially intended for Dungeness, where Mr. Daboll has already erected a smaller signal of this kind.

ARTIFICIAL SUNLIGHT.

FOR many years past attempts have been made to evolve from natural elements a gas or flame which, on a small scale, should equal in quantity and intensity the light emitted from the Sun. So long ago as 1859, Professor Bunsen and Professor Roscoe suggested that the fusion of the metal magnesium might prove to be the solution of the problem; and M. Sondstadt has commenced the manufacture of that metal on a large scale for photographic purposes. It has been demonstrated, that by burning magnesium wire in a spirit or oil lamp, an illuminating power of great brilliancy might be gained. The two Professors long since examined the photo-chemical action of the Sun, compared with a terrestrial source of light, and this latter was effected by the combustion of magnesium wire. The application of this light may become, it is easy to perceive, of vast importance beyond its photographic uses. A burning magnesium wire, of the thickness of 0·297 millimetres, evolves as much light as 74 stearine candles, of which five go to the pound. In order to produce a light equal to that of 74 such candles burning for ten hours, and in which 20 lb. of stearine would be consumed, 72·2 grammes of magnesium wire would be required. The magnesium wire is prepared by forcing out the metal from a heated steel press, having a fine opening at the bottom. For the purpose of consumption, it may be rolled up in coils on a spindle, which, by the agency of clockwork, or weights above, could be made to revolve. A pair of feeding rolls would push the end of the wire forward, at a rate commensurate with the speed of its combustion.

So far as the usefulness of the discovery is concerned in relation to Photography, we have the following testimony from Mr. Brothers, of Manchester:—"The result of an experiment I have just tried, is, that in fifty seconds, with the magnesium light, I have obtained a good negative copy of an engraving—the copy being made in a darkened room. Another copy was made in the usual way, in daylight, and in fifty seconds the result was about equal to the negative taken by the artificial light." Who shall say, therefore, that at some not distant day, nature and science may not place at our disposal a substitute for the bright orb of day—an artificial sun?—*Mechanics' Magazine.*

HUGE FIRE BALLOON.

M. GODARD has made some extraordinary ascents from Cremorne Gardens in a large Fire-Balloon of very peculiar construction. M. Godard's balloon is an enormous structure, made of silk inside, and very plain canvas outside; of the ordinary pear-shape, covered with representations of the French Eagle, and having near the top a blue curtain rim which serves to break the monotony of its whitey-brown surface. It is 117 ft. 7 in. in height; 95 ft. 9 in. in circumference; 300 ft. 6 in. superficial; 30,000 ft. in area; 2005 lb. in weight; 498,556 cubic contents; contains 4793 square yards of silk in 1910 pieces of 96 stripes; 14.203 feet of stitching; 96 overlaps of joints 154 feet long; making 13,848 feet more of sewing. 17,244 feet of galloons, which form the net-work; the galloons are stitched on both sides, and contain 34,349 more feet of stitching. 24 compartments in the parachute require 6824 feet of stitching. The total number, 69,324 feet of stitching, contain 2706 days of work; the valve is 4 ft. 8 in. in diameter, and the appendix is 24 ft. 5 in.; to the opening of the latter are held, rigged by a wooden hoop, 32 cords to sustain the car, which weighs 585 lb., is dish shaped, and 13 ft. 2 in. in diameter, with a border of 8 in., the whole constructed of several pieces, which can be disconnected for convenience of transport. The hoop and the car are also attached by 64 metal cords. In the centre of the car are an 18-ft. stove, including the chimney, 980 pounds in weight; 6 ft. 6 in. in diameter, three cylinders, 3 in. apart from each other, invented by M. Godard, with a view to counteract the effects of the radiated heat upon the occupants of the car: inside the flue is a metal colander to intercept sparks. The combustible employed in lieu of gas is rye-straw, cleaned from the ears, and compressed into blocks. The total weight of the balloon (including the grappling-iron and cords, is 400 lb.; two supplementary pumps, 150 lb.; and combustible, 500 lb.) is 4620 lb. The inflation occupied but 45 minutes.

IMPROVED HYDRO-CARBON LAMP.

Mr. G. SMITH has patented certain improvements in Lamps for burning Hydro-carbon Oils. The oil is contained in a vessel below the burner, which is somewhat of the argand form, modified to suit this particular class of oils; an air-tube is carried entirely through the vessel, and communicates with the external atmosphere by perforations in a stand on which the vessel is placed. The top of this tube is about 3 in. more or less from the top of the supply

vessel. The wick is placed round the central air-tube, the wick elevator being a simple ring with grippers on the inner surface which press portions of the circumference of the wick against the central tube: a rack is fixed to this ring, and is raised and lowered by a trunnion moved by a spindle extending outwards from the side of a pipe to which an outer tube is screwed. This outer tube is carried up to about the same level as the top of the air-tube, and is curved inwards at the top. The top of the wick passes between these two tubes. The gallery carries a deflecting cone, the height of which is capable of regulation up and down the second tube hereinbefore mentioned; but the mouth of the deflector should be kept slightly above the top of the wick. By the particular arrangement of tubes and cone, and the addition of a chimney, hydro-carbon oils are burned without smoke or smell, the deflecting cone being properly regulated to ensure these effects.—*Mechanics' Magazine.*

PETROLEUM OILS.

Dr. Marcet, in a paper read by him to the Society of Arts, thus details the numerous valuable properties of Petroleum as an illuminating agent. It gives off less carbonic acid than any other illuminating material, bearing very favourable comparison with coal gas in that respect; its lighting properties are also superior to many other materials at present in use; its cleanliness and freedom from smell when burning recommend it for domestic purposes. Dr. Marcet then described the various lamps in use for burning petroleum, and gave a decided preference to the lamp with a flat wick of six-eighths of an inch in width. The lecturer then proceeded to consider the objections urged against the use of petroleum, and explained that they only applied to oils from which the lighter and more inflammable portions had not been distilled. To guard against any danger he advised people to test their petroleum before burning it. Mr. Young had recommended a method to effect this purpose without the use of a thermometer, which is applicable both to coal oil and petroleum. He then reviewed the various causes of petroleum accidents, and concluded with an account of his visit to the petroleum wells of Canada. In the discussion which followed, Mr. W. B. Tegetmeier said that the test spoken of by Mr. Young was an improvement upon one which he himself had proposed to that gentleman. His great object was to do away with a thermometer, and afford every means of testing these oils. He believed the standard of safety ought to be fixed at 130 deg. Fahrenheit. Dr. Marcet then called attention to very culpable ignorance on the part of certain Government officials in allowing the *Warrior* ironclad to be lighted by means of an oil or spirit the inflaming point of which was as low as the freezing-point of water, and which gave off inflammable vapour at ordinary temperatures. (The speaker demonstrated this by kindling a small portion of the oil in question at a short distance from the surface of the liquid.) The spirit was used by blowing through it atmospheric air, which became charged with inflammable vapour and burnt like gas. The inventors of this method of illumination gave it the ridiculous name of "ozone gas." The upsetting of a vessel of this spirit in the presence of a light would endanger the lives of 600 men and 480,000*l.* worth of property. Dr. Bachhoffner considered the use of almost every petroleum oil as not unattended with danger. With regard to the *Warrior*, he had no doubt that proper precautions were taken to insure perfect safety. Dr. Paul stood forth as the defender of the use of all petroleum oils, no matter how low their point of ignition, as perfectly practicable and safe. With respect to the dangerous oil used on board the *Warrior*, Mr. G. Wilson thought that valuable vessel was hardly the place in which to try delicate lighting experiments.

At a meeting of the Association of Medical Officers of Health, a paper has been read on the recent petroleum accidents, and on the ready detection of dangerous lamp oils. It was shown that these accidents had invariably resulted from the employment of oils capable of being ignited at a very low temperature, in many cases even below the standard of the Petroleum Act; one very severe accident being traced to the employment of an oil giving off inflammable vapour at a temperature below the freezing-point of water. The author of the paper, Mr. Tegetmeier, exhibited a very easy and practical mode of detecting dangerous oils. Two teacupfuls of boiling water and one of cold water (at the ordinary temperature of a sitting-room) were mixed together in a small basin; a cupful of the water was then taken, and a teaspoonful of the oil to be tested poured on its surface; in a few seconds a light was applied to the oil. The dangerous oils, those capable of igniting below 128 degrees, immediately took fire, whereas it was shown to be impossible to ignite those which were of a safe and non-explosive character. In the conversation that ensued, Drs. Letheby, Lankester, and R. D. Thomson took part, and the desirability of raising the standard of the Petroleum Act from 100 to 125 degrees was discussed; many accidents, some of a fatal character, having arisen from the employment of oils having a higher inflaming point than 100 degrees Fahrenheit.

There has been much controversy as to the safety of petroleum, but we think the matter set right in these few remarks in the *Builder*:—"The advantage is to a certain extent counterbalanced by the danger which attends the use of this material. We hear of constant accidents from its introduction; and we fear that without some carefully considered regulations respecting its sale, the number of fires will be permanently increased from this cause. That there are two kinds of so-called paraffine oil, however, in the market, one of which is by no means dangerous, some traders seem to know, while others are either ignorant or reckless; and it is certain that the very dangerous paraffine is often sold under a warranty that it is safe; by which means many poor women and children are burnt, houses destroyed, and

other mischief is done. No doubt persons who are in this way guilty could be forced to pay damages; but something more than this is needed for the protection of the public."

The danger from using the cheap paraffine lamps is great. Thus, a young girl, while carrying "a penny paraffine lamp," when it got so hot that she dropped it; the oil flared up, the deceased, to get out of the way, jumped over the flame, her clothes caught fire, she was fearfully burnt, and died.

PETROLEUM AS FUEL.

WITH the object of testing the merits and capabilities of Petroleum as Fuel, experiments on an extensive scale have been made at Woolwich Dockyard. The plan is simply to burn the petroleum through a porous material, which is placed in an iron chamber, dipped into a water-vessel, also of iron. The oil admitted into the chamber soddens the porous material, and rises by capillary attraction. The surface then catches fire and burns rapidly as long as the oil is supplied. The effect of the flame is said to be so great, that with the small apparatus, which is only 2 feet superficial area, and affixed to a boiler, the oil has been utilized so as to be equal for steam purposes to five tons of coal. The method adopted is the patented invention of Mr. C. J. Richardson, an engineer residing at Kensington. A third advantage is obtained by the employment of the petroleum—namely, that no stokers are needed, and the boilers can be supplied with several fires one above another. The small grate used in the experiments was placed under a boiler of 17-horse power, and in two hours it raised the steam to 10 lb. pressure.

The objection to the use of this oil beyond its cost, seems to be the fear of explosion. A curious property of petroleum is said to have been discovered by Dr. Decaisne, of Antwerp, who announces that it instantaneously destroys that parasitical insect of the *Acarus* family which produces the human skin disease called itch: all that is requisite is simply to apply the oil without even rubbing; and that the mere vapour of the oil will disinfect clothes tainted with the virus. If all this be true, doubtless there are other skin diseases thus curable; for more than one skin disease originates in parasitical causes. It may also turn out to be useful in gardens.

FUEL IN IRELAND.

AT a meeting of the Royal Dublin Society, an elaborate paper has been read by Mr. Hamilton O'Hara, on "The Supply of Fuel in Ireland." It was characterized by great research, and gave much useful information as to the extent of the coalfields and peat bogs of Ireland, the different varieties of fuel, and how the immense supply of peat, now of little use for manufacturing purposes, may be rendered by improved modes of preparation

nearly as valuable as coal. The area of the bogs of Ireland amounts to 2,830,000 acres, and estimating a cubic yard of dry peat to weigh 550 lb., the quantity of valuable fuel from this source amounts to 6,338,666,666 tons. On pursuing the calculation further, and taking the economic value of turf, compared with that of coal, as 9 to 54, the total amount of peat fuel in Ireland is equivalent in power to about 470,000,000 tons of coal, and estimating coal at 12s. per ton, we find the money value of all the peat in Ireland to be 280,000,000*l.* sterling. Mr. O'Hara referred to the particular qualities of coal found in the various coalfields in the provinces, and quoted statistics as to the quantities found in each, the area occupied in Leinster being 230 square miles. There are 73 collieries at present in Ireland, 31 of which are in Leinster, 29 in Munster, 7 in Connaught, and 6 in Ulster. Of these 46 only are at present worked. The quantity of coal taken from them was 120,000 tons a year, but in 1862 it amounted to 127,000 tons. The number of mines now worked was an improvement on that of former years. In 1853 there were only 19 at work, in 1856 there were 22, and now there were 46.—*Mechanics' Magazine.*

PYRIMONT ASPHALTE.

THE noble area of Trafalgar-square, to the extent of about 80,000 feet superficial, has been laid with Pyrimont Asphalte, upon a carefully-prepared foundation of concrete, by Claridge's Company. Eastward of the Nelson column was stationed an engine by Easton and Amos, the power of which was employed to drive iron arms or agitators within three large caldrons, containing an admixture of Pyrimont asphalte and mineral tar—the former is a bituminous limestone, obtained from mines in France, some blocks of which, rough from the quarry, were, at the time of our visit to the scene of operations, lying upon the ground. These blocks were reduced by steam-power to a fine powder, to which was added a small quantity of grit; and this powder was then transferred to caldrons and brought by heat to a mastic state by the addition of five per cent. of mineral tar, which is also a mineral extract. On attaining a semi-fluid state, the asphalte was removed from caldrons into skips upon trucks along a portable railway to the spreaders, and was laid one inch thick in two layers breaking joint, a smooth surface being obtained by rubbing in a fine powder of slate dust and silver sand. The old pavement was relieved here and there with stars, circles, and margins in Portland cement. This decoration is now effected by red tiles from the Architectural Pottery Company, Poole. This particular asphalte, from its qualities of compactness, durability, and imperviousness to moisture, has stood the test of time, and is likely to prove a useful material. The works at Trafalgar-square are the largest ever executed in this country, not excepting the approach to the Duke of York's steps, which was done by the same company some years ago.—*Building News.*

GAS-LIGHTING RAILWAY TRAINS.

THE North British Railway Company have adopted an improved system of Lighting with Gas the carriages on the Dalkeith and Musselburgh sections of their line; and, so far as the experiment has yet been tested, it has proved highly successful. A large gas-receiver has been erected at the east end of the Waverley Station, and connected with this is an ingenious but simple set of apparatus by means of which a large passenger-train can in the space of a minute be supplied with gas to serve for a pretty long journey. The alterations requisite to be made upon the carriages for carrying out the improvement have been very slight, and the expense trifling. The gas for the supply of the train is contained in a small gasometer formed of elastic material, which is fitted up in the guard's van. From this receptacle an iron pipe is led along the roofs of the carriages, the spaces between the carriages being connected with composite pipes, sufficiently slack to avoid all risk of its being strained or otherwise affected by the motion of the train. The old oil-lamps have been removed from the carriages, and large patent glass globes have been substituted, within which the gas-burners are fastened. The gas can be regulated at will by the guard, and can be turned off at the gasometer, should it be necessary to do so. The light produced by the gas is steady and brilliant, and adds greatly to the comfort and cheerfulness of the carriages. Independent of its striking and manifest advantages, the new system of lighting the carriages has the additional recommendation of cheapness.

RYFFEL'S HYGEIAN STOVE.

THE arrangement of this Stove seems to us very good. Between the fire-box and the outer cylinder there is everywhere a space, so that the latter is warmed only by the heated air, and emits no fumes; while the mode of supplying air to the fire is such as to admit of the most complete control.

When the stove is lighted, no further attention is needed. The smoke is carried off by a small pipe passing into a chimney or flue, or in any other convenient way. In the words of the patentee—"The firewood is lighted on the top of the coal, and the fire then shut in with the cover of the firebox: the supply of air being thus cut off from the top, a vacuum is produced, which immediately causes a downward suction of the fire to, and an upward draught of the air from, the grate; the two elements meet, and the action of the stove is at once established. The coal ignites very quickly. When this has taken place, and the regulator is partially closed, the fire is fed by highly rarefied air, which not only greatly retards the combustion of the fuel, but actually controls the fire in such a manner that, without losing any of its intensity, it can neither increase nor decrease, but continues burning regularly until all the fuel is consumed." The stove is evidently economical, and produces uniformity of temperature.—*Builder.*

MARRIOTT'S IMPROVEMENTS IN BOILERS FOR HEATING BUILDINGS.

THIS invention, patented by Mr. A. Marriott, of Higham Ferrers, Northamptonshire, consists in constructing the Boiler with an annular water space at the top and bottom, these two water spaces being connected together by vertical tubes. The flow pipe is connected to the upper annular water space, and the return pipe to the lower annular water space. The grate is placed in the interior of the lower annular water space, is mounted on pivots, and is capable of being tilted by means of a lever outside so as to empty its contents into the ash-pan. Above the upper annular water space is an annular smoke-box, one side of which is connected to the chimney or flue, and the opposite side to the central fire space, so that the heat and smoke are compelled to pass round the upper annular water space instead of passing directly to the chimney or flue. The ash-pan is enclosed, air being admitted or shut off by means of a damper, which is opened or closed by a regulator constructed as follows:—In connexion with the flow pipe, close to its junction with the upper annular water space, is placed a bulb or hollow sphere of cast iron or other metal; and inside this hollow sphere is placed another hollow sphere of smaller diameter, so that as the hot water passes along the pipe it circulates freely round the inner sphere and communicates its heat thereto. The lower side of the inner sphere is connected by a metallic pipe to an elastic tube closed at the bottom and attached to the damper by a screwed rod and swivel. The upper part of the inner sphere is also furnished with a pipe, which passes upwards through the outer sphere, where it is closed by a screw cap. Mercury is poured into the inner tube through the last-mentioned pipe, filling the sphere and elastic tube, and the cap is replaced. It will now be evident, that, as the temperature of the water increases, it will cause the mercury to expand and lengthen the elastic tube, and thus cause the rod to close the damper; and as the water cools the mercury contracts, and allows the elastic tube to open the damper, and admit air to the fire. It is preferred to make the elastic tube of vulcanized indiarubber surrounded by a coiled wire spring. By placing a thermometer on the flow pipe, and lengthening or shortening the screwed rod accordingly by means of the swivel, the heat of the water may be regulated to any required degree, and maintained at an equal temperature for any desired length of time. Of this improvement the *Mechanics' Magazine* gives illustrations.

WARMING CHURCHES.

IN the *Scotsman* newspaper there are some particulars as to the Warming of Dunfermline Abbey Church by means of the patent multitubular heaters of Mr. W. Clark, jun., of Dunfermline. The church seats over 2000 persons, is lofty in the roof, and lighted by about 1900 square feet of glass, in small panes set in lead-work, far from being air-tight. The area of the church contains up-

wards of 425,000 cubic feet of air; and yet, according to the *Scotsman's* correspondent, this church is sufficiently warmed at a cost for fuel of from 1s. 6d. to 2s. The fire "is lighted about six o'clock on Sunday morning; by seven o'clock it is giving a large amount of fresh warm air; and by the time the congregation assembles the temperature is at 55° to 57°, or above temperate, and by mid-day there is so much heat generated in the heaters that no further coaling is required for the rest of the day. The apparatus is so constructed as to throw into the church a constant, powerful stream of fresh air from the outside, which can be heated in its passage through the heaters to a temperature of 200°, or more if required. It requires no fan-blast, or artificial force whatever, and enters the church with such volume and power that its course can be traced upwards to the ceiling, 50 feet high; and such a constant influx of fresh warm air forces off the vitiated air and prevents the disagreeable effects of cold draughts from openings left for ventilation." The plan is said to have been equally successful in various other churches and other public buildings in which it has been tried.

AMMONIA EXTINGUISHING FIRES.

AN apothecary at Nantes has discovered accidentally that Ammonia will effectually extinguish Fires. He happened to have about 70 litres of benzine in his cellar, and his boy, in going down carelessly with a light, had set fire to it. Assistance was speedily at hand, and pail after pail of water was being poured into the cellar without producing any effect, when the apothecary himself took up a pail which was standing neglected in a corner, and emptied the contents into the cellar. To his astonishment the flames were quenched as if by magic, and upon examination he found that the pail, which belonged to his laboratory, had contained a quantity of liquid ammonia. The result is easy to explain on scientific principles—for ammonia, which consists of 82 parts of nitrogen and 18 of hydrogen, is easily decomposed by heat, and the nitrogen thus set free in the midst of a conflagration must infallibly put out the flames. A large supply of liquid ammonia properly administered would be the promptest fire extinguisher ever imagined.—*Galignani's Messenger*.

APPARATUS FOR FIREMEN.

A SIMPLE and apparently effective Apparatus has been lately constructed by a Mr. H. Kuhfuss, of Carlsruhe, for the purpose of discovering the whereabout of the flames in cases where the smoke would prevent a fireman from entering a house in the ordinary manner. Mr. Kuhfuss does away with the mouthpiece and fresh-air pipe hitherto used in these cases. The apparatus consists of a cap made of light material, and covered with a coating of gutta percha: this cap is drawn over the head, a collar of india-rubber fitting it sufficiently tight round the neck to prevent the smoke from entering. Two holes, filled in with glass, admit light, as in a diving apparatus; and in the region of the mouth and nose two cross incisions are made, which are buttoned up, after a sponge, saturated with strong vinegar, has been admitted, entirely covering mouth and nostrils. Experience teaches that the organs of respiration are not affected by the smoke so long as the sponge is kept wet; and a small bottle of vinegar which the fireman takes with him, enables him to moisten the sponge when required. A whistle, attached to the inside of the cap, completes this very simple contrivance.—*Builder*.

LONDON FIRES DURING THE YEAR 1864.

THE Annual Report of the Superintendent of the London Fire-Engine Establishment deserves attention. In the year 1863 the number of alarms given at the various stations of the metropolis alone was 1624. Of these 81 were false, 139 proved to be only chimney alarms, and 1404 were fires: of which 39 resulted in the total destruction of buildings, &c.; 310 in serious damage; and 1055 in slight damage. The fires of 1863 show an increase, compared with those of 1862, of 101; and compared with the average of the previous thirty years, the increase is 582. This is an enormous increase, which is not to be accounted for by the increase of population and buildings. The report, however, shows that in the management of fires there is an improvement. The totally-destroyed list, 39, compared with that of 1862, shows an increase in number of six; but compared with reference to the average population of the thirty previous years, there is a decrease of nine. The amount of total destruction will, we hope, decline, as the facilities for telegraphic communication are in more complete working order between the various districts and the fire-brigade stations, and through the general introduction of the steam fire-engines; but the figures which follow show that a considerable portion is caused by the distance between the suburban districts and the stations; for of the buildings destroyed, 4 were over 2 miles from the nearest station, 7 over 3 miles, 1 over 5, 2 over 6, 2 over 7, 1 over 8, 1 over 11, and 1 over 12 miles; 3 were lost from want of water, and 1 fell down before the fire was extinguished. We thus learn that a great part of the thorough mischief is done at a distance of about 3 miles from the stations at present established.

Of the 39 totally burnt-out buildings, 18 were completely alight, and 17 others burnt down, before the arrival of the engines. It is said that the telegraphic communication between the chief station and the outlying ones—a plan which we recommended years ago—has been completed; and now we urge, not only the erection of fresh stations, but telegraphic communication in case of fire throughout the part where the total burning is the most rife.

The figures, in connexion with other large cities, are worth note, although the accounts of some of those abroad may not be quite exact. Average per annum:—Philadelphia, 363; New York, 331; Paris, 300; Berlin, 260; Hamburg, 244; St. Louis, 189; Boston, 172; St. Petersburg, 140; Montreal, 104; Brooklyn, 83; Troy, 42; Charleston, 31; Liverpool, 297; Manchester, 238; Glasgow, 221; Dublin, 174; Birmingham, 127; Sheffield, 51; Leeds, 47; Hull, 26; Bristol, 25; Cork, 23; Sunderland, 22; Belfast, 17; Birkenhead, 8; York, 11; Exeter, 10; Waterford, 5; Yarmouth, 4; Tynemouth, 3; and in London, as we have above recorded, 1404.

A Report has also been published, containing statistics as to the number and character of fires which have been attended by the fire brigade maintained at the expense of Mr. Hodges, the distiller, of Lambeth, from which it would appear that the public are vastly indebted to that gentleman, and the men under his command. During the year 1863 the total number of fires attended was 108, whilst in 1862 they only amounted to 60. Of the former, 84 took place on the south, and 24 on the north side of the Thames. Two steam fire-engines, the *Torrent* and the *Deluge*, have been added to the plant of Mr. Hodges' fire establishment, and have proved very effective. 2200 feet of hose and other appliances are kept in thorough repair, and in readiness at a minute's notice.

THE RAILWAY SYSTEM, ETC.

The President of the Institution of Civil Engineers* (Mr. Maclean), in his Inaugural Address, thus forcibly points out the extraordinary effects which our great Engineering Works have exercised, during the last 30 years, in promoting the material and intellectual progress of Great Britain; and showing more especially that the wonderful prosperity attained during that period is to be attributed mainly to our Railway System, which has enabled us to develop the mineral resources of the country, and at the same time to provide secure and reproductive investments for the profits realised by the successful working of the system.

* In the Annual Address, 1863, we find this note upon the origin of the Institution:—It was about the year 1816 that Mr. Henry Robinson Palmer, who was then articled to Mr. Bryan Donkin, first suggested to Mr. Joshua Field the idea of forming a Society of Young Engineers, for their mutual improvement in mechanical and engineering science; and it was no doubt owing to Mr. Field's influence that Mr. William Nicholson Maudslay became the third who associated in this cause. These were shortly joined by five others—Mr. James Jones, Mr. Charles Collinge, Mr. James Ashwell, Mr. Thomas Maudslay, and Mr. John T. Lethbridge—and when the Institution was constituted on the 2nd of January, 1818, it comprised just these eight members, and so remained until the following year, when the number was increased by three. From that time to the present the numbers steadily increased, the first great impetus being the acceptance of the office of President, in 1820, by Telford, under whose fostering hand the Institution grew rapidly in importance, and eventually acquired a permanent position among the scientific Societies of the metropolis.

The total net amount of income derived from all sources available for taxation in 1815, was 152,388,226*l.*, and in 1856, 242,467,368*l.*, showing an increase of 60 per cent., or upwards of 90,000,000*l.* (which, on the basis of the taxation of 1815, would have yielded 9,000,000*l.* additional tax), from sources independent of the land.

The causes of the enormous increase of the income of Great Britain are shown by tables, representing the profits of many hundreds of millions sterling invested in railways, canals, mines, ships, and other works, in this country, in India, and in our colonies.

Fortunately, the Railway System, since the introduction of the locomotive engine, improved by Stephenson, gave it vitality, has been a complete success,—in the reproduction of capital, in the enormous saving in the cost of transport, and in the facilities it affords for the development of mines, and of nearly all branches of national industry.

After the opening of the Manchester and Liverpool Railway, the accumulated wealth of Great Britain, which previous to that time had been but sparingly invested in public undertakings, and was for the most part hoarded, or placed on doubtful securities, was thrown lavishly into the Railway System; and, although for a time this led to the belief, that the supply of capital for the construction of such undertakings was inexhaustible, and induced excess of speculation, temporary distress, and subsequent distrust in the system; yet the progress of railways ever since that period has been steady, and a reproductive profit has been assured on a capital of nearly 400,000,000*l.* This vast capital has been created because railway securities, on the principle of limited liability, occupy the highest place in public estimation, for investing the realised profits of the country, in consequence of the facility with which they can be purchased, and transferred in amounts suited to the requirements of every class of society; and this leads to a constant accumulation of capital by inducing people to save a portion of their income—not merely for their own support in an after-period of life, but for the benefit of their descendants. Thus railway securities afford the means of transmitting wealth, as printing does knowledge, from one generation to another.

The beneficial effect of the Railway System has not been confined to Great Britain. Before the introduction of railways the land was nearly the only safe means in Europe for the investment of capital; and, in consequence of the competition for this security, the interest was reduced to a minimum rate, and was barely sufficient to induce people to save a portion of their income. The construction of railways, by inducing saving, has established a wealthy and educated middle class in most countries in Europe, who have not only developed the industrial resources and increased the capital of the country to which they belong, but have also, as in this country, promoted education, and humanized the conduct of all classes of the people.

With respect to railways as a cause of the increase of wealth,—

the land occupied by railways in Great Britain is under two hundred thousand acres, including stations and other conveniences; and to obtain possession of this land it has been necessary, during every session of Parliament, for the last thirty years, to engage the services of the ablest counsel and the most eminent engineers in the committee rooms of both Houses at an incalculable expense. The land used for agricultural purposes is about forty million acres; yet the Railway System, occupying only about one half per cent. of the total area of the land, now pays nearly as great an amount of Income and Property Tax as is paid by the whole of the farmers of Great Britain.

CAPITAL EXPENDED ON RAILWAYS.

THE Capital expended in this country on Railways to the present time has been upwards of three hundred and eighty-five millions sterling, or nearly half the National Debt. This amount has been devoted to the construction of eleven thousand five hundred miles of railway in the British Islands, which are now open for traffic. The works executed in connexion with these undertakings have been of extraordinary magnitude. Navigable rivers, and even arms of the sea, have been crossed over; hills have been pierced by tunnels, and viaducts, embankments, and cuttings made in all directions. All this has been accomplished within the life-time of a single generation of men, who have not only executed the work, but provided the means out of their private resources, without any assistance whatever from the funds of the State. In a word, the railway system of England has been the spontaneous out-growth of the native industry, energy, and enterprise of its people.—*Railway News.*

LOCOMOTION BY HYDRAULIC POWER.

MR. W. SYMONS, in a paper read to the British Association, proposes for metropolitan underground, or other railways, to have fixed steam-engines at convenient distances, whose work will be to pump water into hydraulic accumulators: this water-power, under pressure, to be conveyed in pipes along the railway. At proper distances, wheels, as in Messrs. Hawthorne's plan, must be placed; but, instead of wire-ropes, each set of wheels must have connected with it a small hydraulic engine; or, where two lines of rail are used, it may be placed between the two. The train, while progressing, would turn on and off the water, as required, and thus no useless power would be expended. By the same sort of power, Mr. Symons proposes to work through certain wide streets narrow lines of railway contained in and on tubular viaducts, with open latticed sides and bottoms, so as not to obstruct the light and air: these viaducts to be supported on iron arches; one pillar of these arches to be in a line with the curb stones of the street pavement, and the other against the houses.

SPEED OF RAILWAY TRAINS.

THE necessity of an apparatus for measuring the Rapidity of Trains, in order to ascertain whether they have kept within the bounds assigned to it by the regulations, has long engaged the attention of engineers. This problem, it is asserted, has been solved by MM. Borde and Meritens, by an apparatus consisting of a pulley placed in the centre of a large wheel, and receiving motion by means of an endless strap from one of the wheels of the locomotive, or one of the carriages. The large wheel turns independently of the pulley, and by means of a system of gearing, it effects a single revolution during the whole trip; while a second pulley, put into communication with the first one, turns with the same rapidity as the latter. Meanwhile, a centrifugal regulator impresses a forward or backward motion on a pencil, according as the rapidity increases or diminishes, and the marks left by this pencil on a piece of circular paper determine the rapidity of the train at a given moment.—*Mechanics' Magazine.*

RADIAL AXLE-BOXES.

MR. W. BRIDGES ADAMS has exhibited at the Conversazione of the Institution of Civil Engineers a large and beautifully finished model of a locomotive engine frame fitted with his Radial Axle-Boxes; an invention likely to work a revolution in the construction of railways, as by its aid curves become admissible which could not be tolerated under the ordinary system of fitting axle-boxes. The model was one of a six-wheel engine, placed on a curve equivalent to a real line of but 95 ft. radius; and the action of the radial boxes fitted to the leading and trailing wheels was beautiful in its extreme simplicity, and admirable in its fitness to the required end. The boxes finished to the proper curve, move laterally in the horn-plate guides in such a manner that the axle becomes parallel with the radii of all ordinary curves, and approximates more or less nearly to those which are exceptional. There is no forcing, under this arrangement, of the rigidly framed engine round curves, and a vast amount of wear and tear of rails and tyres is thus avoided; a proportionate amount of power being saved. Engines so fitted are working daily on the St. Helen's line, in Lancashire, with the utmost success.—*Mechanics' Magazine.*

HIPP'S ELECTRIC SIGNAL FOR RAILWAYS.

AT the conversazione of the Institution of Civil Engineers, also has been exhibited a half-sized model of M. Hipp's Electric Safety-Distance Signal for Railways. M. Hipp is an electrician of Neufchatel, and the Signal is patented as a communication to Mr. John Imray, engineer, London. The idea involved in its construction is extremely ingenious, but it would be hopeless to attempt to explain the mechanism without engravings. Suffice it to say that the signal consists of a column surmounted by a disc,

which is turned edge-ways to the line for safety, or flat-ways for danger; and for night signals, it is provided with a lantern with alternate white and red lenses, as usual. The disc is turned by means of a clock-weight descending in the inside of the column, which has to be wound up at intervals of two or three days, according to the number of times the signal is used. The mechanism on which the weight acts is stopped by an electro-magnetic detent, which is connected by conducting wires, like those of the telegraph, to a small battery and manipulating instrument at the station. The manipulating instrument is contained in a small case or cabinet fixed against the wall of the station-master's office. It consists of a handle or lever moving over an arc, half white for safety, and half red for danger—an electric bell, and an indicator or model disc, which always shows the same phase as the main disc on the distance signal. At any moment, the station-master, by simple inspection of the instrument, sees how the signal stands, whether at "danger," or at "safety;" if at "danger," the handle is on the red, and the indicator disc shows red; if at "safety," the handle is on the white, and the indicator disc in the office shows white. When he desires to change the signal, he moves the handle from red to white, or from white to red, as the case may be, and immediately the bell begins to sound, and continues to sound until the distance signal has turned, and the indicator disc has undergone a corresponding change. In case of any accident happening to the distance signal, of its mechanism being run down, or of its becoming stiff by grit, or rust, or violence, so that the weight cannot turn it, the bell at the station continues to ring, and the station-master can take temporary measures for safety. In case of anything happening to the electrical portion of the apparatus—the battery being exhausted, or the wires being broken—the indicator disc shows, like a galvanometer, the absence of electric power and the bell does not sound on moving the handle. In such case, also, the station-master can take temporary measures.—*Mechanics' Magazine.*

THE MONT CENIS RAILWAY.

In a paper read by Mr. Sopwith, to the Institution of Civil Engineers, he thus describes the tunnelling in this great work:—"In M. Sommeiller's system, whilst machinery was employed for accelerating the progress usually made by hand labour, gunpowder was also available. He succeeded in producing a compact machine, not weighing more than 6 cwt., which could pierce a common borehole, about 1¼ in. diameter, and 3 ft. deep, into a rock in twenty minutes, where two miners would have required two hours. Further, he arranged a moveable support capable of carrying eleven such machines, any one of which could be worked at almost any angle, and of allowing the free action of each, in a gallery 10 ft. square. This support could be removed when it was necessary to explode the holes bored by the machines.

The machine was of very ingenious construction. It consisted of two parts: one, a cylinder for propelling the borer against the rock; the second, a rotary engine for working the valve of the striking cylinder, turning the borer on its axis at each successive stroke, and advancing, or retiring, the striking cylinder, as occasion required. It gave 250 blows per minute. The effective pressure on the piston in striking was 216 lb.; the length of the stroke was from 2 in. to 7½ in. Although simplified as much as possible, the nature of the work the machines performed was so severe, that they were liable to frequent derangement, and a large stock was kept on hand. The cost of each machine was about 80*l.* The compressed air was used at a pressure of five atmospheres above atmospheric pressure, and was conveyed to the "fore-head" of the advanced gallery by a pipe 7⅞ in. in diameter. The advanced gallery was the only place where the machines were used; the enlarging of the tunnel to the full size, walling, &c., were performed by manual labour.

The system of working was to bore eighty holes in the forehead of the advanced gallery. The frame and machines were then withdrawn, and a set of men charged and fired the holes; afterwards replaced by another set to remove the *déblais.*

Two descriptions of machines for compressing air were in use—one on the hydraulic-ram principle, the other resembling a pump. In the first, the water was admitted, with a pressure of 85¼ ft., into a column, or vessel, containing air, about 14 ft. high and 2 ft. in diameter. The water by its momentum rushed up the column, compressed the volume of air, and forced it through a valve into a reservoir. The pressure-valve being closed, the exhaust valve was opened, and the water fell in the column, at the same time its place was taken by air, and the machine became ready for another stroke. This machine made 2½ strokes per minute, and was capable of supplying about 20 cubic ft. of air, compressed to five atmospheres, per minute. The other machine consisted of a horizontal pump and two vertical branches. The piston was surrounded by water, which rose and fell alternately in the two columns; when it rose, compressing the air, and forcing it through the outlet valve; and when it fell, creating a vacuum, which was filled by air at atmospheric pressure.

The result of a rough comparison was to show that, in the present development of the Sommeiller system, an advancement three times quicker than by hand-labour might be effected, but at about two and a-half times the cost; judging rather of places where it might be generally applied, than by the Mont Cenis only. The proportion of two and a-half to one increase of cost referred only to what was known as mining charges in the advanced gallery, *i. e.* wages, tools, candles, and gunpowder. This proportion was notably diminished in the case of a railway tunnel, where enlarging, timbering, walling, laying of rails, &c., were charges common to both systems. In the case of a tunnel through rock, costing, when completed, 30*l.* per yard, the two

systems might compare as follows:—an increased advancement in favour of machinery of 3 to 1, at an increased cost of 4 to 3.

The Simplon Railway is to follow as closely as possible the famous road built by Napoleon, described by Sir James Mackintosh as "the greatest of all those monuments that at once dazzle by their splendour and are subservient to general convenience." There is no doubt that the railway over and through the granite mountain will be a still greater monument of human skill and enterprise. Napoleon's road took six years to complete, and cost about half a million sterling; the railway, it is calculated, will be constructed in five years; but at an expense of above three millions.

MONT CENIS LOCOMOTIVE EXPERIMENTS.

It is projected, says the *Railway News*, to make a tunnel shorter than that of Mont Cenis, and work the necessary steep gradients, on both the Swiss and Italian sides of the Alps, by means of powerful locomotives, similar to those in use on the Sœmmering Mountain, on the railway from Vienna to Trieste.

Mr. Fell, in concert with Messrs. Brassey and Jackson, has proposed to the French and Italian Governments to lay down a tramway on the present Mont Cenis route, covering the same with wooden, iron, and stone galleries, and working it by means of a new and lighter species of locomotive, so that the distance between Susa and St. Michel, which now takes ten, might be safely and regularly traversed in a period of from four to five hours. The first series of these Mont Cenis Locomotive Experiments for producing a low engine capable of carrying a train of 100 passengers with their luggage over the mountain, has had satisfactory results. The trials have been made on an incline of 1 in 13 (the Mont Cenis being 1 in 12), and the experimental engine, a new one on Mr. Fell's peculiar system, has taken up and down the entire load proposed, whilst the brake power for descending is most perfect. A great number of practical and scientific men witnessed these locomotive trials with much interest; and the second series of experiments was made on a gradient of 12, and curves of 30 and 50 metres radius combined, for which a piece of line was constructed the *fac-simile* of the Mont Cenis. These experimental operations have been carried on at the Cromford and High Peak Railway, Whalleybridge, and, as may be easily supposed, it is hoped by their means to solve the problem of a rapid and comparatively cheap communication, not only across the great passes of the Alps, but likewise over those of the Apennines.

It is well known that the whole length of the Mont Cenis tunnel when completed, will be 12,220 metres. The machine used for the purpose is M. Sommelier's perforator, set in motion by compressed air. On the Bardoneche side in the year 1864, the average advance per month was 50 metres; on the Modane side it did not exceed 38 metres per month, owing to the greater hardness of the rock on that side; there still remains a length of about 8250 metres to be got through. When completed, the tunnel will have required the piercing of 1,220,000 holes, 550,000 kilogrammes of gunpowder, 1,550,000 metres of slow match; the number of bayonets rendered unserviceable will amount to 2,450,000.—*Mechanics' Magazine.*

GREAT ENGINEERING FEAT IN BRAZIL.

In July last, M. Brunlees accomplished the first experiment in his daring scheme to lift a Railway over the great Serra do Mar, which at Santos separates the seaboard from the interior of the country. The San Paulo Railway, a line in the hands of English capitalists and English directors, runs from the port of Santos into the country to the village of Jundiahy, a distance of 88 miles, touching on its course the capital city of San Paulo. Eight miles from Santos commences the vast mountain chain which runs along the coast for hundreds of miles, and is known as the Serra do Mar. It seems to assume its grandest proportions at the only point where the province of San Paulo can be entered from the sea; and it is at this point that science has been called upon to grapple with the tremendous difficulty of crossing the dividing ridge by a railway which attains in the course of five miles of mountain steep an elevation of 2000 feet. The conquest of this enormous difficulty by the skill of the engineer opens up the most important province in Brazil to easy access from without, and will give a rapid and cheap means of exit to the boundless products of a coffee-growing country, fertile beyond example.

From Santos to the commencement of the ascent the railway runs over a swampy country, wretchedly rotten, and reeking with miasma; till crossing the Cutatao River, eight miles from the sea, it approaches by a woody defile in the rocks, the gorge up which it has to climb, till, 2600 feet above, it passes out through an opening in the heights on to the "campos," over which it runs on into the interior of the province. It is this enormous ascent which gives to the undertaking its emphatic character. Passing the Mugy river, and at each step becoming more and more confined, the black defiant ravine is suggestive of anything rather than an outlet for a railway course, which goes winding and ascending, crossing mountain torrents, leaping gloomy chasms, cutting through solid rocks, still working upwards, till at length, after five miles of such Titanic effort, it passes out on to the "open."

The entire ascent is divided into four "lifts," or inclines, of a mile and a quarter each, running at a gradient of 1 in 10. A level platform, or "bankhead," marks the summit of each incline, and at the upper end of the platform is a stationary engine. This engine has double cylinders of 26 in. diameter, with a 5 ft. stroke, and has been calculated to haul up 50 tons at the rate of 10 miles per hour. Five boilers of the Cornish description are placed

with each engine. On the upper half of each incline there is a double line of rails, with arrangements for passing places on the middle of each of these "lifts." A single line of rails then runs on from the centre to the foot of each of the four divisions into which the ascent is divided. A steel wire rope, 1½ in. diameter, is made for pulling up the ascending trains. This rope, tested to a weight far exceeding the requirements that will be made upon it, passes over friction wheels, and is attached to the fly-wheel shaft. The inclines are, therefore, partially self-acting, at the same time passing one train down to the foot of the Serra, and drawing up another to the higher levels on its way out to the province beyond.

The above description of one of these inclines will serve for the whole. The mechanical contrivance is in each case substantially the same, and the nature of the steep over which the line passes varies very little. On the third division there is a ravine, more gloomy than any other. This "Bocca do Inferno," is 900 ft. in span on the level of the railway, crossed by a viaduct, resting upon clusters of iron columns, which spring up from enormous stone piers 200 ft. below the centre of the line which passes over them.

The first of the four divisions being in operation, to witness the inaugural experiments, the Brazilian Government commanded the presence of the President and his official staff, when the writer of this account passed by permission over the inclines with the rest of the company.

Passing the Mugy river and reaching the foot of the Serra, there was a little delay while the locomotive was uncoupled, and the train was attached to the rope by which the visitors were to be hauled up into the cloudy levels above us. Soon the train was got into motion, and by slow hesitating paces commenced the ascent. Presently the speed improved, and the motion became smoother, and in eight minutes they were on the level platform which forms the "bankhead" of the first lift of the inclines, having passed at the centre point the down-train, which was running on to the level below. Once or twice on the ascent the train came to a standstill, and the ascending and descending carriages were suspended and held fast midway on their courses, by way of demonstrating the absolute safety and control in which all the operations were held by those who had charge of the machinery on the levels above.

The ascent was in the highest degree satisfactory, and at the conclusion of the trials and examinations made by the President, his Excellency expressed his sincere pleasure at what he had seen, and his conviction that an immense, almost an insuperable difficulty had been completely vanquished by the daring skill and persistent efforts of engineering science. Some 18 months would yet be required, however, to complete the line on its entire length of 88 miles to Jundiahy.

In Europe, the success of the engineer in his attempt to cross the Serra do Mar, will be appreciated, as a conquest won by science in a district yet new to commercial enterprise.—*Times.*

THE PNEUMATIC RAILWAY AT SYDENHAM.

In the Crystal Palace grounds, a series of trial trips on the model Pneumatic Railway, recently constructed there, under the superintendence of Mr. Rammell, C.E., has been made with perfect success, in the presence of several eminent engineers and scientific men. A brickwork tunnel, about 10 ft. high by 9 ft. wide, and capable of admitting the largest carriages used on the Great Western Railway, was laid with a single line of rails, fitted with opening and closing valves at either extremity, and supplied with all the other requisite apparatus for propelling passenger trains on the pneumatic principle. The tunnel, or tube, extends from the Sydenham entrance of the grounds to the Armoury, near the Penge-gate, a distance of nearly 600 yards. The object of laying down this experimental line is to afford, both to the scientific world and the travelling public, a practical demonstration of the applicability to passenger traffic of the motive power already employed by the Pneumatic Despatch Company in the conveyance of letters and parcels. The pneumatic principle of propulsion is very simple. It has been likened to the action of a pea-shooter, and the train the pea, which is driven along in one direction by a strong blast of air, and drawn back again in the opposite direction by the exhaustion of the air in front of it. The train may be said, in fact, to be blown through the tube on the down journey, and sucked through it on the return journey. It must not, however, be supposed that the passengers are deposited at their destination with a sudden jerk. Such an inconvenience is entirely obviated by the mechanical arrangements employed. The motion is throughout smooth, easy, and agreeable, and the stoppages are effected gently and gradually. Indeed, when it is considered that the curve in the tunnel is unusually sharp, being of eight chains radius, and that the gradients are as high as 1 in 15 (those of Holborn-hill being only 1 in 18), it is surprising that the motion should be so much steadier and pleasanter than ordinary railway travelling.

The journey of 600 yards was performed either way in about 50 seconds, with an atmospheric pressure of only 2½ ounces to the square inch; but a higher rate of speed, if desirable, can easily be obtained consistently with safety. Indeed, one great incidental advantage of this species of locomotion is that it excludes all risk of the collisions occasionally attendant on railway travelling; for it is plain that no two trains could ever run full tilt against each other where all the propelling force is expended in one direction at one time. The train used consisted of one carriage, resembling an elongated omnibus, and capable of accommodating some 30 or 35 passengers. Passengers enter this carriage at either end, and the entrances are closed with sliding glass doors. Fixed behind the carriage there is a framework of the same form, and nearly the same dimensions, as the sectional area of the tunnel; and attached to the outer edge of this frame is a fringe of bristles forming a thick brush. As the carriage moves along through the tunnel

the brush comes into close contact with the arched brickwork, so as to prevent the escape of the air. With this elastic collar round it, the carriage forms a close-fitting piston, against which the propulsive force is directed. The motive power is supplied in this way:—At the departure station a large fan-wheel, with an iron disc, concave in surface and 22 feet in diameter, is made to revolve by the aid of a small stationary engine at such speed as may be required; the pressure of the air increasing, of course, according to the rapidity of the revolutions, and thus generating the force necessary to send the heavy carriage up a steeper incline than is to be found upon any existing railway. The disc gyrates in an iron case resembling that of a huge paddlewheel; and from its broad periphery the particles of air stream off in strong currents. When driving the air into the upper end of the tunnel to propel the down-train, fresh quantities rush to the surface of the disc to supply the partial vacuum thus created; and, on the other hand, when the disc is exhausting the air in the tunnel with the view of drawing back the up-train, the air rushes out like an artificial hurricane from the escape valves of the disc case, making the adjacent trees shake like reeds, and almost blowing off his feet any incautious spectator who approaches too near it.

When the down journey is to be performed the breaks are taken off the wheels, and the carriage moves by its own momentum into the mouth of the tube, passing in its course over a deep air-well in the floor, covered with an iron grating. Up this opening a gust of wind is sent by the disc, when a valve, formed by a pair of iron doors, hung like lock-gates, immediately closes firmly over the entrance of the tunnel, confining the increasing atmospheric pressure between the valve and the rear of the carriage. The force being thus brought to bear upon the end of the train, the latter, shut up within the tube, glides smoothly along towards its destination, the revolving disc keeping up the motive power until it reaches the steep incline, whence its own momentum again suffices to carry it the rest of the distance. The return journey, as above indicated, is effected by the aid of the exhausting process. At a given signal a valve is opened, and the disc-wheel set to work in withdrawing the air from the tube. Near the upper end of the tube there is a large aperture, or side-valve, which forms the throat through which the air is, so to speak, exhaled, the iron doors at the upper terminus still being kept shut. In a second or two the train posted at the lower terminus, yielding to the exhausting process going on in its front, and urged by the ordinary pressure of the atmosphere from behind, moves off on its upward journey, and rapidly ascending the incline approaches the iron gates, which fly open to receive it, and it emerges at once into daylight.

Such is the mode in which the system works, and it seems capable of being adapted to railway communication within the metropolis and other large towns, or wherever tunnelled lines with steep gradients exist. The chief obstacles encountered in

practically working the atmospheric railway, introduced some fifteen years ago, are considered to have been effectually overcome by the present modification of the principle. Under the former system the tube was of very small size, and fixed upon the ground; a longitudinal or continuous valve opening at the top, along which a rod, connecting the piston with the carriages, passed, and the valve closing behind the rod as it moved onwards. The amount of atmospheric pressure required to be exerted where the area of the tube was so small was enormous, being from 7 lb. to 10 lb. per square inch; whereas upon Mr. Rammell's principle the pressure is only 2½ oz. per square inch; and, moreover, the great leakage and waste of power which rendered the old atmosphere system so costly in working, are here in great measure avoided. It need hardly be added that the worst drawbacks to travelling through tunnels—viz., the smoke and sulphureous vapours emitted from the locomotive, and the close, unwholesome atmosphere of the tunnels themselves—are in this case got rid of. Every train, in fact, carries its own supply of fresh air along with it, and also expels the foul air before it.—We quote this excellent report from the *Times*.

STEAM-BOILERS.

Mr. Zerah Colburn has read to the British Association a paper, in which he entered at considerable length into the theory and practice connected with Steam-boilers, pointing out the causes of failure and bursting; showing the value of cast-iron as a material for the purpose, when of a spherical form; and that small cast-iron spheres do not retain the solid matter deposited from the water. Small water tubes and small water spaces in ordinary boilers always choke with deposit when the feed-water contains lime; but cast-iron boiler spheres, although they may be temporarily coated internally with scale, are found to part with this whenever they are emptied of water. This fact is the most striking discovery that has been made in boiler engineering. It removes the fatal defect of small subdivided water spaces, which can now be employed with the certainty of their remaining constantly clear of deposits.

This discovery has been made in the use of the cast-iron boiler, invented by Mr. Harrison, of Philadelphia, United States, and which is now working in several of the midland and northern counties. Mr. Harrison employs any required number of cast-iron hollow spheres, 8 in. in external diameter and 3-8ths of an in. thick, communicating with each other through open necks, and held together by external tie-bolts. A number of these spheres is arranged in the form of a rectangular slab, and several of these slabs set side by side and connected together form the boiler; about two-thirds of the whole number of spheres being filled with water, while the remainder serve as steam room. The bursting strength of these spheres corresponds to a pressure of upwards of

1500 lb. per square inch, as verified by repeated experiment, between six and seven times greater than that of the ordinary Lancashire boilers of large size. The evaporative power, as in all other boilers, depends upon the extent and ratio of the grate area and heating surface. In practice, from 7½ lb. to 8 lb. of water are evaporated per pound of coal in a cast-iron boiler, which for each ton of its own weight supplies steam equal to ten indicated horse-power. The joints between the spheres are made by special machinery securing the utmost accuracy of fitting, and there is no leakage either of water or steam; the spheres occupied as steam space are screened by fire-bricks from the direct action of the heat, but enough is allowed to reach them to secure complete drying, and if desired any degree of super-heating of the steam. The slabs into which each series of spheres is assembled are placed in an inclined position, which secures the thorough circulation of the water. The whole quantity of water carried in a 40-horse boiler is 3 tons, the boiler weighing 13 tons and presenting 1000 square feet of water-heating and 500 square feet of steam-drying surface. In Manchester, with the feed-water taken from the Irwell or from the canal, a hard scale is soon formed in the ordinary boilers; but in the cast-iron boiler a succession of thin scales of extreme hardness is found to form upon and become detached of themselves from the inner surfaces of the water spheres. The scales are blown out with the water at the end of the week, and only small quantities can be discovered when purposely sought for. (A specimen of these, slightly cohering together in a friable mass, was exhibited.) A pint of loose scales and dirt is the most that has yet been found in a careful internal examination after nine months' daily work. None of the iron is removed with the scale, the weight of the spheres, after three years' service, being the same as when new. In America, Mr. Harrison's cast-iron boiler has been worked six years. Messrs. Denton, chemists, of Bow Common, have had one in use for three years; and, for the last two years, the same description of boiler has been employed at Messrs. Hetherington's and other large works in Manchester. It should be added, that the system of casting the spheres is such that their thickness is necessarily and invariably the same at all points. The self-acting action, which has been found to be the same in all cases where the boiler has been worked, has been explained by conjecture. It deserves the careful investigation of the chemist and mechanical philosopher, with whom the author prefers to leave the subject. A discussion took place, in which Mr. Webster and others joined—expressing a very favourable opinion of this new form of boiler.

MONSTER STEAM-HAMMER.

Messrs. R. & W. Morrison, of Newcastle-upon-Tyne, have forged the largest and most powerful Steam-Hammer in the world, for the Russian Government. The piston-rod to which the hammer

is attached is a ponderous piece of metal, weighing no less than 42 tons in its rough forged state; and now, when dressed down to the required dimensions, it has only been reduced to 35 tons. The length of the piston-rod is 58 ft., the diameter 2 ft. 4 in., having a stroke of 14 ft. 6 in., the piston being 6 ft. 8 in. The forging of this mass of metal occupied 44 days. The cylinder for this hammer was cast at the Elswick Engine Works. Its diameter inside is 6 ft. 8 in., its weight upwards of 49 tons. The standards weigh nearly 40 tons each. The united weight of the hammer-bar, the cylinders, and standards, amounts to over 150 tons.—*Builder.*

CAUSES OF THE EXPLOSION OF STEAM-BOILERS.

In the *Philosophical Magazine* is a note, by M. Dufour, on this important subject in relation to the phenomena of the ebullition of water. We give the chief points. Gases tend eminently to promote the vaporisation of liquids with which they are in contact; but the superficial gaseous layer which adheres to solids, acting at first like gases themselves, is gradually removed by prolonged and successive heatings. When the solid surfaces are deprived of it, they no longer by their contact excite changes of condition, but become indifferent in the liquid. By maintaining or producing on the surface of bodies a gaseous layer, ebullition of a liquid is immediately produced if the temperature be suitable, and any retardation of ebullition be avoided. The following experiment realises these conditions:—Two platinum wires communicating with the outside, pass through a cork on which a thermometer fits, and dip in water. They are connected with the two poles of a galvanic element, and a slight disengagement of gas, due to electrolysis, takes place on their surface. So long as the current passes, it is impossible to obtain the least retardation in boiling. If these wires cease to be connected with a battery, after some successive heatings, and by diminishing the superficial pressure, retardations are produced similar to those mentioned above. If the current be then made to pass, ebullition is immediately produced. If the retardation be considerable (from fifteen to twenty degrees), closing the circuit produces so abundant a production of vapour as to resemble a true explosion. The vapour appears to break away with an effort from the liquid mass, and the vessel experiences concussions almost strong enough to break it. This experiment (says M. Dufour), which has frequently succeeded in my hands with ordinary water, is more striking in the case of slightly acidulated water, for then the retardations are more pronounced. It is therefore a property of water to tend, in most cases, to retain the liquid state, even when the ebullition ought to take place, providing the boiling point has been reached by a diminution of the superficial pressure after the liquid has been already heated, and after it has been in contact for some time with the solid substances of the vessel. This property is per-

haps not without interest in its application in the explosions of steam-boilers.

Various attempts have been made to explain it; among others, by saying that in a perfect calm, while the issue of vapour is suspended, everything being motionless in the apparatus and all the dissolved air expelled, the water may accidentally become heated beyond the point corresponding to its pressure, and then, if ebullition sets in, it suddenly furnishes a mass of vapour which breaks the envelopes. But the embarrassing circumstance, and the one found in most cases, is that the accident takes place without the heating having been continued, while the workmen and the machine were at rest, and when from cooling the pressure in the machine had diminished. These conditions, almost always mentioned with surprise in these accidents, exhibit an undoubted analogy with the experiments described. Is it not possible that at a moment of repose, and while the heating has been discontinued, the cooling that sets in at first, diminishes the pressure of vapour existing in the boiler? As water, in virtue of its great specific heat, cools very slowly, it retains for a longer time a temperature which ought to produce ebullition under this diminished pressure. This ebullition doubtless takes place most frequently in proportion as the diminution of pressure permits; but it may happen that, under exceptional circumstances, a retardation similar to that above described is produced, and that after a longer or shorter delay, ebullition sets in, either spontaneously or in consequence of some foreign disturbance. This ebullition ought to manifest the characters many times observed in my apparatus, where the concussions raised the heavy support to which the retort was fixed. From the large quantity of water contained in a boiler, these strokes might well cause a fracture of the sides and the disastrous effects of this kind of accidents.—*Illustrated London News.*

CONDENSATION OF STEAM IN LONG PIPES.

SOME information, exceedingly interesting to engineers, has been made public in an account of a subterranean engine erected in the celebrated "Gould and Curry" mine, California. The engine is 50 horse-power, and is 201 ft. below the surface of the ground. Where the Gould and Curry pipe was packed with ashes it lost but 5 lb. in going 1100 ft.; whereas in the straw-jacketed pipe, at the New Almaden mines, the steam lost 14 lb. in going only 1300 ft. There would seem to be a much greater gain from preventing radiation by packing the ashes loosely around the pipe. Dr William Charles Wells, in his work on "Dew," states that it is first apparent on wool and similar filamentous substances. From this, says the *Scientific American*, we might argue that the heat from the earth is cut off from them; that they remain cold, and are consequently good non-conductors. The greatest neglect is apparent in carrying steam-pipes to a distance. In many cases they are not even covered with canvas, but are exposed to all sorts of atmospheric influences. Such practices are deliberate and wilful extravagances, for which there is no excuse whatever.—*Mechanics' Magazine.*

REMARKABLE STEAM-BOILER.

A REMARKABLE Steam-boiler has been patented by Mr. Edward N. Dickerson, of New York, and has exhibited such results as to astonish the practical men who witnessed the trial. The *Providence Journal* says:—The boilers stand on the dock without any chimney whatever, so that the only draught was that which was produced inside of the boilers themselves, which usually would not serve to make steam in less than two or three hours of firing. In these boilers, however, steam was produced in seventeen minutes from the time the fire was lighted; and in half an hour the pressure was about 70 lb. to the inch. The safety-valve was then opened, and the steam blown off at a pressure varying from 70 to 30 lb. to the inch. At the pressure of 30 lb. the safety-valve was blocked up, but the steam could not be blown down below that point, although the safety-valve is about twice as large in proportion to the grate surface as is usual, and the fire was made of ordinary cord-wood, burning without any chimney. Instead of blowing off water from the open valve, as boilers usually do, nothing but pure steam could be seen, thus showing that no heat is lost by working water; and the products of combustion as they pass from the boiler tubes are so cooled, that persons were walking on the perforated plate through which the hot gases were escaping, without burning shoes or clothing, and the hand could be held at the aperture of the tube without any inconvenience whatever. Before the boilers were fired up, they were subjected to a cold-water pressure of more than 100 lb. to the inch, which they endured without complaining. The boilers are less than half the usual size, and yet they make pure steam without any "steam chimney," in less than a quarter of the time usually required, and in far greater quantities, from the same weight of fuel, than any other boiler ever constructed can do.

MINIATURE STEAM-ENGINE.

A MINIATURE working model of a pair of Penn's patent Trunk Engines has been made by Mr. Thomas Smith, modeller, of 20, Walnut-tree Walk, Lambeth. These engines are *fac-similes* of those in H.M.S. *Warrior*. The model engines, however, are intended to work at high pressure, whereas the *Warrior's* are condensing engines. The weight of the pair of model engines is two grains less than that of a silver three-penny piece; and they stand on less space than a silver three-penny piece would cover. The cylinders are 3-32nd of an in. in diameter. Length of stroke

1-16th of an in. The throw of the eccentric is 1-60th of an in. The engines are constructed with the link-motion reversing gear. The hexagon-headed bolts used for fastening on the cylinder covers are 1-100th of an in. in diameter. The engines can be worked at from 20 revolutions per minute up to 20,000 revolutions per minute.—*Mechanics' Magazine.*

THE LENOIR GAS-ENGINE.

THIS Engine, invented by M. Lenoir, of Paris, under the auspices of the Imperial Gas Company of that city, and now in extensive use there, has been introduced into America, as appears from the *American Gas-Light Journal*, which thus describes it :—The Lenoir engine is in appearance and style very much like a horizontal steam-engine, having a cylinder, piston, crank-shaft, and fly-wheel. The cylinder has the necessary slide arrangements for the admission of the gas (the ordinary city coal-gas, supplied from the service-pipes) and atmospheric air, in due proportions : the gas is ignited at the proper moment by the electric spark from a battery connected by wires to each end of the cylinder—the connexion being made and detached by the rotary action of the crank-shaft. The expansive force consequent on the ignition, gives motion to the piston on each side alternately. The cylinder has a water-jacket surrounding it, through which a stream of water is kept gradually flowing, to keep it cool. The engine, once fixed, the battery charged, and the gas turned on, it is ready for action at any desired moment, needing no engineer to superintend its working ; and as soon as the work required of it is completed, and the gas shut off, the engine instantly stops, and the expense ceases. The daily cost of gas and chemicals is trifling, and there is no boiler and no chimney. It can be worked on any floor of a house, and almost under any circumstances.

CALORIC ENGINES.

MR. ROPER, of Boston, has explained to the Polytechnic Association of the American Institute at New York, with the aid of diagrams, the Caloric Engine lately in use at the Sanitary Fair. This engine is designed to be used where small power is required. Its peculiarity is, that it does not use, upon the piston, common air, heated, but only the products of combustion. The air to supply oxygen for the combustion of anthracite coal is pumped in ; the carbon is burned rapidly and completely, under pressure, and the resulting carbonic acid gas and uncombined nitrogen gas from the air, are passed from the generator to the piston, which is in the form of a hollow plunger, so arranged that it is packed and fitted only at the top, where there is the least heat. In this way the common difficulty of lubricating a hot cylinder and piston is obviated. The generator of heat is surrounded with fire-brick or soapstone, which prevents the iron from being burnt. The engine is single-acting ; that is, the power is applied to the piston moving in one direction, during which movement the air to feed the fire is pumped in ; the momentum acquired at the same time, by a balance or fly-wheel, is used to carry the piston back to its original position. The diameter of the air-pump in the engine at the Fair is 12 in. ; that of its piston is 16 in. ; the difference in the areas of the pump and piston, multiplied by the usual pressure, 8 lb. per square inch, shows that this engine exerts a two-horse power. It requires about 10 lb. of coal per hour, it occupies five square feet of room, and weighs 3000 lb.—*Mechanics' Magazine.*

PRESERVATION OF METALS.

A NEW pigment, calculated at the same time to increase the resources of the decorative painter, and to afford a ready means of preserving iron and other metals, has been successfully introduced at Paris by M. L. Oudry of the Auteuil Electro-Metallurgic Works. He first obtains an absolutely pure copper by throwing down the metal by the galvanic process ; he then reduces the precipitate to an impalpable powder by stamping. This powder is then combined with a particular preparation of benzine, and used in the same way as ordinary paint ; beautiful bronzed effects are produced upon it by means of dressing with acidified solutions and pure copper powder. The articles painted with the new material have all the appearance of electro-bronze, whilst its cost is less than one-sixth ; it will last from eight to ten years. M. Oudry also proposes to substitute benzine-oil for linseed and other oils, over which it possesses great advantages.—*Mining Journal.*

COVERING METALS.

M. WEIL has read to the French Academy of Sciences a communication "On New Processes for Covering Metals with firmly adherent and bright layers of other Metals." The method consists in dipping the metal to be coated in a saline solution of the metal to be deposited, rendered distinctly alkaline with potash or soda, and mixed with some organic matter, such as tartaric acid or glycerine. At the same time, it is necessary in some cases to set up a weak voltaic current by keeping a piece of zinc or lead in contact with the metal. In this way the author obtains a firm layer of copper on iron and steel, and procures various and beautiful effects according to the thickness of the copper deposited. Silver, nickel, and other metals can be applied in the same way. The process, it will be seen, is susceptible of numerous applications. A curious fact mentioned is that a clean surface of copper may be coated with zinc by placing the two metals in contact in a solution of caustic soda or potash. In the cold the deposit of zinc takes place slowly, but at 100 deg. it is effected rapidly.—*Mechanics' Magazine.*

METAL TUBES FOR SUBMARINE NAVIGATION.

In 1863, among the Russian preparations for war, it was stated that one means for the defence of the Neva approved by the authorities was a Submarine Boat of colossal dimensions, in the construction of which two hundred tons of iron and steel were to be used, and which was then rapidly progressing towards completion. The cost was set down at 175,000 silver roubles (about 27,000*l.*) It is to have engines worked by compressed air, to have a very strong beak, with provision for attaching large cylinders charged with powder, to the bottoms of vessels, to be fired by electricity. The parties navigating the vessel will see what they are doing by means of "bulls'-eyes," and they will be able to regulate the depth at which they swim, generally keeping quite close to the surface. This statement, which attracted much attention when it was first published, is confirmed by the Editor of the *Mechanics' Magazine*. Messrs. James Russell and Sons, of the well-known Crown Tube Works, Wednesbury, have received a commission for the apparatus which is to contain the motive power, consisting of above two hundred wrought-iron tubes, varying in length, the average being about twelve feet. The diameter of these tubes, which are intended for the reception of the compressed air, is thirteen inches, and the thickness of the plates used in their fabrication is nearly five-eighths of an inch, the material employed being the best Staffordshire iron. The ends are first forged by the steam-hammer, and are inserted and welded by blacksmiths, so as to render each tube air-tight. They are afterwards proved and screwed for connection pipes. The pressure which they are expected to bear is 1500 lb. to the square inch; but they are proved up to 2000 lb. per square inch, and those which are not equal to that strain are rejected. The average weight of the tubes is half a ton. Mr. James Russell, more than forty years ago—namely, on the 19th of January, 1824—obtained the first patent for the production of welded tubes for gas from strips of sheet-iron.

INDURATION OF IRON.

The iron-work of the new Bridge at Blackfriars is to be indurated by a process patented by Messrs. Morewood and Co., and is alike important from the great cost which will be incurred, and the testing of a rather abstruse chemical formula for the preservation of iron from oxidation and decay. The process is as follows:—The iron is to be thoroughly cleaned and heated to the requisite temperature, in a furnace planned by the inventors. When this temperature is attained, it is to be plunged into a bath of prussiate of potash, and chloride of potassium, in a molten state, so that when the iron is withdrawn, it may easily part with the surplus of the aforesaid chemicals, which should run off like oil. The iron is then to be dipped into boiling water, containing a certain portion of cyanide of potassium; from thence it is removed to a bath for a final washing, and set up on end to dry. All the processes are to be carried on under cover, and before exposure to the atmosphere the iron is to be coated with an asphaltum paint twice, at given intervals; and again it is to receive two coats after fixing. Of course all the necessary planing, drilling, and fitting is to be done preparatory to the indurating. The time the iron is to remain in the bath will vary from one to five minutes, according to the weight of the metal to be operated upon. The elaborate character of the process, to which the contractor is rigidly bound, will account for the large sum to be expended in carrying out this part of the work. 4*l.* per ton is allowed to the contractor for the induration and painting. Messrs. Morewood will receive from the contractors 5*s.* per ton as their royalty, which it is estimated will be 1000*l.* Thus, 16,000*l.* is to be spent in this effort to prevent oxidation, no greater proof of which, in its damaging results, can be offered, than the case of the cleaning of the oxide (or rust) from the Menai Bridge, from which has lately been removed above forty tons of oxide of iron.—*Mechanics' Magazine.*

LARGE SAFE.

One of the largest Safes ever constructed has been completed by Messrs. Chubb and Son, of St. Paul's-churchyard, for an Indian Bank. It is 14 ft. long, 10 ft. deep, 8 ft. high, and is of the enormous weight of 17 tons. Small cash safes, secured by detector locks, are fitted to the interior, and the outer doors are fastened by four locks, throwing twenty-seven bolts.

THE ELASTICITY OF IRON.

Mr. James Williams has read to the British Association a paper on the above subject as follows:—It is a common saying, "rigid as a bar of iron," and but few persons are aware how very flexible iron, as well as other metals, is. Many builders in introducing cast and wrought girders or beams to support enormous weights, are of opinion that such beams are strong enough to what they call "bear any weight without bending," and are much surprised to be told by a mechanician that these same girders, however stiff they may appear, will not even bear their own weight without considerable deflection. Many good working mechanicians even are quite unaware of the extreme subtlety of the metal they are operating on. It is only that class of mechanics who are engaged in scraping up valve-faces, slide-lathes, and similar tools, and above all, attempting to make "flat surfaces" and "straight edges," that can comprehend in a fair way the trying difficulty of keeping such works true after they have once got them so. In the engineers' workshop, where straight bars of metal are used for the purpose of testing the work under process of manufacture, it is necessary to keep at least three bars or surfaces of each kind

for the purpose of testing each other; for it has often been known that a straight edge, got up with all the care and accuracy possible, true to day will be bent to-morrow; indeed, the very handling of it while in use is quite sufficient to distort to such a degree that the workman frequently has to put it by awhile until it comes to the natural temperature of the room he works in; the partial heat of the hands alone being sufficient to render it useless for its object. In getting up straight edges and flat surfaces, if two only are used to test each other, it is all but a certainty that one will be hollow and the other rounding: by using three we are enabled to discover this defect, for supposing one to be hollow and the other two rounding, to exactly match; then if the two rounding surfaces are put together the detection is easy, and is corrected accordingly. Great difficulty has often been experienced by astronomers, particularly with reflector telescopes, in keeping the true figure of the speculum, and most ingenious contrivances have been made to accomplish that end, the most perfect being a system of tripods resulting in a bearing of three single points. No wonder at the precautions taken, when, the difference on a 20-in. speculum between a true spherical curve and the necessary parabolic curve is only the two-millionth of an inch. It is very easy, indeed, to speak about millionths of an inch, but very few minds can comprehend a division of matter so small as the one-millionth of an inch; and in order to some extent only, to understand it, Mr. Williams devised the experimental straight-edges exhibited, a set of which he prepared for the Great Exhibition of 1851; when they attracted the attention of the late Prince Consort, by whose order Mr. Williams re-exhibited the experiments at Buckingham Palace. Mr. Williams added that his object was more to show the flexibility of iron and steel by experiments than to surprise by mere statement; and proceeded to describe the bars, apologising for their want of fine finish, as they were only the ordinary tools taken somewhat suddenly from the workshop.

We quote the above from the Report of the Proceedings of the Meeting of the British Association, held at Bath, in September, 1864. The report was first given in the special daily edition of the *Bath Chronicle*, and subsequently corrected and reprinted in a large 8vo form, extending to 300 closely-printed pages. The appearance of this corrected Report almost immediately after the close of the Meeting was a well-timed advantage, hitherto rarely accorded to the Association. The reprint is illustrated with an able photographic portrait of the President of the Meeting, Sir Charles Lyell, Bart.

AMERICAN STEEL.

THE past half-century has been called the "iron age," and the coming fifty years may be called the steel age, if some of our enthusiastic friends may be believed. We must now have steel rails, steel boilers, and steel everything else that requires great

strength, wearing qualities, and a saving of dead-weight. Steel wire for suspension-bridges would seem to become a necessity upon this same reason. In the minor details of mechanical engineering, the use of this material is becoming more and more prominent every day. To meet this greatly increased demand, quite a number of enterprises has been started in different parts of the country, of more or less magnitude; each of which is now doing a very considerable amount of business. In Pittsburgh there are four very considerable establishments; in and adjacent to New York city there are half-a-dozen more; in Philadelphia one or two, one extensive in Boston, and several more scattered through the country. Some of these establishments are turning out five or six tons per diem, one of them is turning out two tons daily for the Metallic Car Spring Company, to be used for springs. The extensive steel-works at Wyandotte, lately put up by the enterprise of Captain E. B. Ward, and which are now soon going into operation, is a most important enterprise to the West. Here the Bessemer method is to be used, the proprietor having secured not only all the necessary machinery, but workmen thoroughly instructed in the process. The war, the consequent high tariff upon foreign imports, and the high rate of exchange, all act as a sort of blockade upon foreign goods; and our manufacturers and capitalists, with the aid of foreign skilled labour, are determined to put our production of metals on a par with their foreign contemporaries, even if they do not within a very few years surpass them in the extent and useful qualities of their manufactures. In no other country in the world is there now so good a chance for skilled labour as in the United States, and the ill-paid iron workers of foreign countries should not neglect this opportunity to better their condition by coming here at an early day and taking fortune at its flood.—*Railway Times.*

COLD-DRAWN STEEL TUBES.

MESSRS. HAWKSWORTH, HARDING, AND CRISTOPHE'S beautiful process for drawing Steel Tubes cold is a process apparently destined to effect a revolution in the manufacture of ordnance. A Company has been formed for the purpose of working this patent on an extended scale, and which has been for nearly two years experimentally worked in Paris, where large orders are now in hand for gun and rifle barrels. The Ordnance Department of France having caused this process to be examined and reported upon with satisfactory results, negotiations are at present on foot for the supply of the Imperial Government. It is mentioned that the unanimous opinion of scientific gentlemen who have examined this method of manufacture is that by its means the problem will be solved of obtaining lightness combined with great strength; for of the gun-barrels subjected to trial at the proving-houses of London, Birmingham, and Paris, those intended to be burst only yielded under tests of the most unexampled severity, and invariably

bulged before bursting. Large guns, built of a series of tubes thus produced, welded together cold and rifled by pressure, the skin of the metal being thus preserved intact, will possess all those elements of strength hitherto unattainable, and which artillerists have vainly desired. The terms of purchase are considered to be highly favourable. There can be no doubt whatever that this invention embodies what is virtually a new art.—*Mechanics' Magazine.*

STEEL BOILERS.

EXPERIMENTS have been made in Prussia with Steel Steam-boilers, an account of which has been published in *Dingler's Polytechnic Journal.* A steel boiler of the egg-end shape, 4 ft. in diameter and 30 ft. in length, without flues, was tried. It had a steam-drum 2 ft. in diameter and 2 ft. in height, and the plates were 1-4th of an inch in thickness. Beside it there was placed another boiler, similar in every respect, excepting that the plates were of iron 0·414 of an inch in thickness. The steel boiler was tested by hydraulic pressure up to 195 lb. on the inch, without showing leakage, and both the iron and steel boilers were worked under a pressure of 65 lb. on the inch for about one year and a half. During this period, the steel boiler generated 25 per cent. more steam than the iron one; and when they were thoroughly examined, after eighteen months' practical working, there was less scale in the steel than in the iron boiler. The former evaporates 11·66 cubic ft. of water per hour; the iron boiler 9·37 cubic ft. The quantity of coal consumed was on an average 2706 lb. for the steel one in 12 hours, and 2972 lb. for the iron boiler. The plates of the steel boiler over the fire were found to be uninjured, while those of the iron one were almost worn out. In Prussia several worn-out plates of iron boilers have lately been replaced with steel, which, it is stated, lasts four times as long. As steel is twice as strong as iron, thinner plates of the former may be employed for boilers, and more perfect riveting can be secured. A greater quantity of steam can also be generated in the steel boiler on account of its thin plates, and thus much fuel may be economized. These improvements should engage the attention of all who make and use steam boilers for engineering and manufacturing purposes.—*Mechanics' Magazine.*

THE IRON TRADE OF THE WORLD.

NOTHING, says the *Mining Journal,* has so much contributed to the comfort and civilisation of the human race as the development of the various industries and extended enterprises which owe their existence to an abundant supply of Iron. Perhaps the most striking development of material progress during the last 35 years is the introduction of the Railway System. During that period there have been constructed 113,000 miles of railway in the

world; and this appears to us as the mere prelude to the extension of this enterprise on a scale so vast as scarcely any living man can conceive. There has been expended on these 113,000 miles of railway already constructed upwards of 40,000,000 tons of iron.

Great Britain and France control the world, and, fortunately for the happiness of mankind, they seem to have elected in favour of peace; and their enormous resources, which might otherwise have been dissipated in war, will unquestionably be diverted to that other great enterprise, which we regard as having merely commenced—the construction of railways, which, proceeding at an increasing ratio, will only be retarded by the limited supply of iron that can be furnished by the mines of the world. The immensely increased demand for ships and steamers built of iron will also of itself form a large drain upon our production of this mineral.

There are now about 350,000 tons of iron in warehousekeepers' stores in Scotland, which is the only reliable reserve for a trade embracing 4,000,000 tons per annum. The shipments of pig iron from Scotland in the past year have been 401,600 tons, showing an increase of 26,649 tons over the corresponding period of last year; and the foundries and malleable iron-works in the district have been so actively employed as to give rise to a consumption of about 12,000 tons weekly.

MELTING WROUGHT-IRON BY ELECTRICITY.

PROFESSOR OWEN DOREMUS employs in this process the great galvanic battery which he uses to illustrate his lectures on electricity. The cups hold one gallon each, and 360 of them are filled and in operation. Standing in close rows, they nearly cover the floor of a long room. The conductors from the ends are copper ribbons an inch and a half in width, and they are led through holes in the wall into the lecture-room. This enormous battery enables Professor Doremus to exhibit the various effects of galvanism to his classes on the greatest scale. The light produced by the carbon points is far in excess of that resulting from the heating of lime by the oxyhydrogen blowpipe. This is demonstrated by employing the two in the solar microscope. By this electric light crystals of uric acid not larger than the head of a small pin are magnified to the size of ten feet, with perfect definition of outline and structure.

Among the effects of the battery which Professor Doremus exhibited is the decomposition of potash by the current. To direct the current into the cup of potash the pole was terminated by a wrought-iron rod about the size of a lead pencil, and in the course of a few seconds the end of this rod was melted, a drop slowly gathering and finally dropping off, when it scattered in a hundred sparks. A common class experiment with this battery is the volatilization of gold. A quarter of eagle gold piece is placed on a carbon support, and the current directed upon it, when the

gold rises as a yellow vapour. If a silver cup is held over it, the cup is gilded by the deposit of the golden fumes.—*Scientific American.*

THE STRENGTH OF WROUGHT-IRON GIRDERS

Has been critically examined by Mr. William Fairbairn, F.R.S., who has printed the results in tables, &c., in the *Proceedings of the Royal Society*, No. 61. He says that, from his experiments, it is evident that Wrought-Iron Girders of ordinary construction are not safe when submitted to violent disturbances equivalent to one-third the weight that would break them. They, however, exhibit wonderful tenacity when subjected to the same treatment with one-fourth the load; and assuming, therefore, that an iron girder bridge will bear with this load 12,000,000 changes without injury, it is clear that it would require 328 years at the rate of 100 changes per day before its security was affected. It would, however, be dangerous to risk a load of one-third the breaking weight upon bridges of this description, as, according to the last experiment, the beam broke with 313,000 changes; or a period of 8 years, at the same rate as before, would be sufficient to break it. It is more than probable that the beam had been injured by the previous 3,000,000 changes to which it had been subjected; and, assuming this to be true, it would follow that the beam was undergoing a gradual deterioration, which must some time, however remote, have terminated in fracture.

PRESERVATION OF IRON IN WATER.

M. Becquerel has contributed to the French Academy of Sciences a memoir "On the Preservation of Iron and Cast Iron in Soft Water." The author had previously announced that iron-plated vessels could be preserved from oxidation by fixing bands of zinc over the iron plates at intervals. It seems that in soft water the protection is not so complete, and a larger surface of zinc is required to ensure perfect preservation. The present memoir is devoted to a statement of the electric condition of the plates, which shows that in salt water the current set up at the point of contact of the two metals extends a long distance, and that the intensity diminishes very slowly. In soft water, however, the intensity diminishes rapidly; nevertheless, the protection may be made complete, as we have said, by the use of a larger surface of zinc. The author found that 9387 cannon balls of 12 centimetres diameter under soft water required for their protection bands of zinc having a surface of two square metres. M. Becquerel makes another suggestion for the protection of water-pipes of cast-iron in wet earth. If these should prove sufficient conductors, they might be protected for great distances, and it would only be necessary to have openings at intervals to allow of the zinc being got at for the surface to be cleaned.

PHOTOGRAPHS OF IRON AND STEEL.

Mr. H. C. Sorby has exhibited and described to the British Association, "Microscopical Photographs of various Kinds of Iron and Steel." He first detailed the manner in which the sections of iron and steel are prepared for microscopical examination. The final process consists in acting with very dilute acid on level and perfectly polished surfaces, showing no scratches, even when examined with the microscope. The acid, acting on the different constituents, or on different crystals, in a variable manner, causes the structure to be exhibited in very great perfection, by various colours or tints. He then explained the precautions required in taking enlarged photographs direct from the prepared surfaces of iron or steel; and exhibited a series photographed under his directions, by Mr. Charles Hoole, of Sheffield, illustrating the various stages in their manufacture. In the case of cast iron, the photographs show the graphite and several different compounds of iron carbon, as well as pure iron. In wrought iron, the character of the crystals and the arrangement of the slag are well seen, and the change in the constituents and in the structure, which occurs when it is converted into steel, is very striking. Other photographs show the change in structure produced by melting and hammering steel. Some meteoric irons have a structure very different from that of any of these artificial irons, as shown by another photograph. On the whole, then, when such sections are thus examined, we may see most clearly the cause of those peculiarities in physical structure which give rise to the different kinds of fracture characteristic of different sorts of iron and steel, and which are so intimately connected with those properties which make each variety more or less suitable for special purposes.

IMPROVED IRON AND STEEL MANUFACTURE.

Dr. John Percy has read to the Royal Institution a paper upon this important process. Chemically pure iron, it was stated, is excessively rare, and hardly ever seen, since even in the electro-deposit of iron, nitrogen is frequently present. In the different forms of the metal, bar or wrought malleable iron, pig or cast iron, steel, &c., carbon is found, in proportions varying from 0·3 per cent. to 4½. Other substances found with iron are manganese, silicon, phosphorus, and even organic compounds (such as the hydro-carbon olefiant gas); but the principal element to be separated from the ores (or oxides) of iron, is oxygen. This was done by the ancients in the primitive smelting-furnace, by the agency of charcoal and the bellows in a most simple form. Yet the principle was highly philosophical; and all the improvements made have consisted in enlarging and raising the height of the furnaces, utilising the waste gases (especially carbonic oxide of high calorific power), substituting the hot for the cold blast, &c. These successive improvements were described in detail by Dr. Percy, aided by diagrams, some of the principles being shown by experiments. The result of this progress, even during the present century, is the production of about 680 tons of iron per week, instead of 50, from a single furnace. The large amount of charcoal

required for the furnaces, led to the gradual use of pit-coal; beginning in the sixteenth century, by Earl Dudley and others. Dr. Percy stated that he considered Bessemer's process of manufacturing homogeneous iron (in which the temperature of the metal is raised by blowing on it cold air) was not novel, and could not be successful, since it failed to eliminate the deleterious element phosphorus. The adaptation of a part of the process in the manufacture of steel is found to be very advantageous. Our readers will find the fullest detail of these interesting manufactures in Dr. Percy's book on the subject, recently published. It contains clear accounts of most elaborate experiments, illustrated by engravings drawn to scale.—*Abstract in the Illustrated London News.*

AN IRON LETTER.

THE *Birmingham Journal* has received by the American mail a Letter, which is remarkable both as a documentary curiosity and as a specimen of manufacturing skill. It is written on iron rolled so thin that the sheet is only twice the weight of a similar sheet of ordinary note paper. The letter is dated, "South Pittsburgh (Pennsylvania), November 6th, 1864," and says:—"In the number of your paper, dated October 1st, 1864, there is an article setting forth that John Brown & Co., of the Atlas Works, Sheffield, had succeeded in rolling a plate of iron 13½ in. thick. I believe that to be the thickest plate ever rolled. I send you this specimen of iron made at the Sligo Iron Works, Pittsburgh, Pennsylvania, as the thinnest iron ever rolled in the world up to this time, which iron I challenge all England to surpass for strength and tenuity. This, I believe, will be the first iron letter that ever crossed the Atlantic Ocean.—Yours, &c., John C. Evans." The iron is said to be of exceedingly fine quality, and the sheet by far the thinnest ever seen in this country. Tested by one of Holtzappfel's gauges, the thickness of the sheet is found to be one-thousandth part of an inch! A sheet of Belgian iron, supposed hitherto to be the thinnest yet rolled, is the six hundred and sixty-sixth part of an inch thick; and the thickness of an ordinary sheet of note-paper is about the four-hundredth part of an inch.

NEW HORSE-SHOE.

ONE of the few novelties shown at the Bath and West of England show, was a Horse-Shoe, patented by Mr. Fowler, the inventor of the steam-plough. In this invention, the object, it is said, has been obtained, which has long been sought, of introducing a spring under the horse's foot in a practical manner, so as to lessen the blow that is so fatal to the soundness of horses which have to travel over hard stones, instead of their natural pathway, the turf. If any elastic material is introduced between an ordinary shoe and the hoof, the rebound of the spring tears the shoe from the foot. To obviate this difficulty, Mr. Fowler uses a double shoe, and places the elastic between them. The second shoe is connected with the foot by means of rivets, which hold it firmly, but allow the necessary movement for the spring to act. It is hoped that the spring shoe will prove as useful to the public and as profitable to the inventor as the steam plough.—*Mechanics' Magazine.*

MALLEABLE CAST-IRON.

AMONG a large majority of those engaged in the arts, Malleable Cast-Iron has always been a metallurgical mystery. The mode of its production is generally a secret in the few foundries where it is made, and the very ignorance of its true character has prevented its use to anything like the extent it deserves. M. Brüll not long since communicated to the French Society of Civil Engineers a very complete account of the history, mode of production, and properties of malleable cast-iron, which deserves to become widely known.

M. Brüll states that the density of malleable castings is hardly greater than that of ordinary cast-iron. Three samples of the former, selected at random, had a specific gravity of 7·10, 7·25, and 7·35 respectively. The colour, both external and that of the fractured specimens, approaches that of steel. The "malleablised" metal takes readily a very fine polish, which is not very easily destroyed upon exposure to moisture. Its resistance under cutting tools, or when exposed to friction, is not, however, great. The metal is very porous, as is proved by the gradual diffusion of oil over a considerable surface where only a portion was placed in a reservoir of that liquid. The Ulverstone white iron is very sonorous, and good clock-bells are cast from it. The treatment of malleable castings diminishes this property of communicating sound; but of two objects of the same form, that in malleable cast-iron can be distinguished from that in wrought-iron by the superior note given off on striking it. On breaking a malleable casting the converting process appears to have penetrated only to the depth of 1-8th and 1-6th inch; and instead of a gradual transition from one condition to another, there is a well-defined line of demarcation. Yet the core, originally brittle, is found to have become soft and easily workable. Worked under cutting tools, the outside of a malleable casting gives long and elastic shavings; while, as the tool enters beneath the surface, the chips, towards the centre of the casting, become more and more brittle. Under twisting and other strains, the interior cracks, while the exterior presents its customary appearance of toughness. Malleable cast-iron is easily stamped, drawn, and hammered without heating. It can also be worked well under the hammer at a low heat, and at this stage hammering appears to improve the grain. At a higher heat it breaks into fragments. Very small sections may be, now and then, welded; but, on the whole, malleable cast-iron is not weldable. It is, however, readily brazed with copper. It

melts only under a very high heat, and, indeed, it stands fire so well, that it is employed for foundry ladles, crucibles for the precious metals, and for the tubes of some descriptions of boilers. Malleable cast-iron may be case-hardened more readily and to a greater depth than wrought-iron. The castings are not blistered, sealed, or warped in the process, and the case-hardening may be effected either with bones, hoops, or leather in the ordinary manner, or with prussiate of potash.

MM. Morin and Tresca have made an extensive series of experiments upon the resistance to rupture, limit of elasticity, &c., of malleable cast-iron, all of which are recorded in the *Annales du Conservatoire des Arts et Métiers*. The strength per unit of section was found to diminish greatly as the dimensions of the pieces submitted to experiment were increased. The direct resistance to rupture was found, in some of the experiments, to be about 50,000 lb. per square inch, or exactly 35 kilogrammes per square millimètre. As to the general results of these experiments, M. Brüll observes that they indicate a general resistance, a co-efficient of elasticity, and a limit of elasticity as great in malleable cast-iron as in good wrought-iron. This was, indeed, to have been expected from the ordinary practical acquaintance which we have of the first-named material. M. Brüll touches upon the prices at which malleable cast-iron is produced in various countries. In Switzerland, for example, it costs upwards of a shilling a pound, while at Liége the cost of castings in this material is not much greater than that of English cast-iron. The whole question of the employment of malleable cast-iron turns really upon that of its cost. If it can be cheaply produced, and we have no doubt that, with simple improvements, it may be, it may be readily substituted in place of many applications of wrought-iron. A Glasgow firm has already done something in this direction, but the subject should be more generally pursued by others.—*From the Engineer.*

CLIFTON SUSPENSION BRIDGE.

This stupendous structure has been opened for traffic. The bridge, as our readers are aware, has been formed out of the old Hungerford Suspension Bridge at Charing Cross. "But (says the excellent account in the *Builder*) although the Clifton Bridge has been completed in December, 1864, its foundations may be said to have been laid in December, 1753—more than a hundred years since—when 1000*l*. were given by Mr. William Vick to the Society of Merchant Venturers, to be placed at interest till it amounted to the sum of 10,000*l*., when it was to be applied to the construction of a bridge over the river at Bristol. Vick contemplated the erection of a stone bridge at Rownham ferry. An iron bridge, however, was thought preferable; and in 1830, when 8000*l*. had been accumulated, plans were advertised for, and Telford was ultimately commissioned to prepare a design; but the estimated cost was no less than 52,000*l*. An Act of Parliament was got, and new designs were obtained from Brunel, Telford, and other engineers; but still something like 50,000*l*. seemed to be requisite. Mr. Davies Gilbert gave his advice, and Brunel's plan was agreed upon. Telford would have had the bridge supported on gigantic columns, reared at great trouble; but his more daring rival determined to make the cliff support the structure, and he estimated the entire cost of the construction at 57,000*l*. Fortified with their design, which was satisfactory to the majority of the inhabitants of the city and neighbourhood, the trustees, in 1831, determined to commence the all-important undertaking, the Society of Merchant Venturers having given the land necessary on the Clifton side of the river, and Mr. P. J. Miles the stone from the quarry at Leigh necessary for constructing the pier at that side of the river.

"The first stone was excavated, but the Bristol riots put the arrangement out of joint, and little was done till 1835, when wire was in the ascendant as the projected material of the bridge, and 35,000*l*. the estimated cost. Mr. Brunel then modified his scheme, but the Bristolians were not satisfied. Still the preliminary works were in progress: a wire was stretched across the river; and the foundation of the Somersetshire buttress was laid when the British Association visited Bristol. In 1837 the contractors became bankrupt, but in 1840 the buttress was completed, and in 1843 the money was all spent, 45,000*l*. having been realized and disposed of in massive piers, &c., ere one-half of the iron-work for the bridge, flooring, toll-house, &c., were executed, and 30,000*l*. more were requisite to finish the work. In 1853 the works ceased, and the undertaking was for the time abandoned. For seven more years matters remained *in statu quo*, when the idea of using up the Hungerford Suspension Bridge was entertained, after Lieut.-Colonel Serrell, C.E., of the United States, had offered to complete the bridge with wire for 17,000*l*. It was in 1860 that Mr. W. H. Barlow and Mr. J. Hawkshaw were consulted, and gave a favourable opinion as to the use of the Hungerford materials; and it is from these materials the bridge over the cliffs has at last been completed. The materials were purchased for 5000*l*. The total cost of the bridge has been nearly 100,000*l*.

"The Clifton Suspension Bridge differs considerably in its dimensions and details from the old bridge at Hungerford, from the materials of which it is principally constructed. The span of the centre is much greater, being upwards of 702 ft. There are no half spans at either side as there were at Hungerford, and the strength of the chains has been materially increased, three chains being employed at each side instead of two; thus nearly one-third more iron work is required than could be derived from the Hungerford bridge. The general arrangements of the chains, saddles, &c., are almost identical with those we have just described. Between a strongly ribbed and massive cast-iron basement and

the main saddle are interposed a double set of steel rollers 4¼ in. diameter and 2 ft. long, the two sets being arranged side by side in a frame, thus giving a rolling surface of rather more than 4 ft. in breadth. These rollers allow of each saddle travelling to and fro upon its basement according to the expansion of the chains. To the main or lower saddle are attached the two lower chains; above the main saddle is bolted an auxiliary or upper saddle, to which is attached the uppermost chain. There are of course four similar saddles, one for each set of chains at each tower; and the weight of each, with basement, rollers, &c., complete, is about 30 tons.

"It was originally intended that the total width of the platform should be 24 ft., giving a carriage-road of 16 ft., and two footways of 4 ft. each. To meet the wishes of Sir Grevile Smyth, these dimensions were increased; and, as actually constructed, the carriage-road will be 20 ft. wide, and each of the footways 5 ft. 6 in. Neither the carriage nor footways are perfectly level, the carriage-way being raised in the centre, and the footways rising towards the outward edge. According to the specifications, the floor of the carriage-road is composed of sleepers of well-seasoned Baltic timber securely tongued together, over which is laid transversely another flooring of planking 2 in. thick. The floor of the footways is of planking 2¼ in. in thickness. The under framework of the bridge is constructed of light iron girders, the top and bottom of each consisting of 3½ in. × 3½ in. × 5-8 in. in wrought angle-iron, strengthened and connected together by diagonal trusses of 2½ in. × 5-8 in.; bolted by their top flanges to the longitudinal lattice girders 3 ft. deep, which separate the carriage-road from the footways. To the upper flanges of these are bolted at the proper distances attaching pieces, to which the lower ends of the suspending rods are attached by pivot-bolts.

"The footways thus project entirely beyond the suspending rods, and are only bounded on the outside by a light iron balustrade rather more than 4 feet in height. The double system of girders gives great strength and rigidity to the bridge, with very little weight of material; in fact, four-fifths, at least, of the iron-work in the whole structure consists of the saddles and main chains, the bridge or roadway itself weighing comparatively little. The total weight of the whole is stated to be about 1500 tons, of which the links and bolts forming the chains are about 1100 tons, the four saddles with their appurtenances nearly 120 tons, and the suspending rods, 20 tons; the remainder will give some approximation to the weight of the roadway."

The following additional details are given in the *Times'* report:—

"There are in all 4200 links in the chains, each link, as we have stated, being 24 ft. long. The bolts or pins are 25 in. long, screwed at each end; the number of bolts is 400. There are 162 suspending rods, which are 1⅝ in. in diameter, and vary in length from 3 ft. in the centre of the bridge to 65 ft. next the towers, the deflection of the chains being 70 ft., or 20 ft. greater than that of the Hungerford-bridge. The cross girders which support the flooring are 80 in number, and weigh about a ton each. It being necessary that the

chains should be somewhat deflected on entering the ground, a cast-iron saddle very similar in construction to those on the tops of the towers, but of course without rollers, is fixed to a foundation of brickwork at the top of the anchor pit, and to this saddle the chains are attached in the same manner as to the other. As they descend from this the three chains separate from each other, in order to afford room for their separate fastenings, and the anchor pits therefore increase in dimensions towards the bottom, which is 70 feet below the surface. There the rock is formed into abutments, upon which rest the massive brick arches, 8 ft. in thickness, which have to bear all the weight of the bridge. In this brickwork are left three apertures, through which are passed the last links of the three chains. At the back, one over each aperture, are placed the three cast-iron anchor plates, through which the links are also passed, and are then secured by strong double keys, and whereas each of the three chains passes entire through one aperture of sufficient size in the brickwork, in the anchor plates there is a separate slit or aperture for each link. Each link therefore passes through its own aperture, and one strong double key driven through all the links secures the whole. Each anchor plate measures 5 ft. by 6 ft., and weighs nearly three tons. The cross section of the chains amounts in the aggregate to about 462 square inches, and allowing the iron of which they are composed to sustain but nine tons to the inch, they would require a strain of over 4000 tons to cause fracture. The company in their Act have taken power, too, it appears, to limit the weight that shall come upon the bridge in two clauses. The first of these provides that no one conveyance or vehicle, the weight of which with its load exceeds six tons, shall be able to come upon the bridge without the company's consent; the second clause provides that the company shall not be bound to permit a total load, including foot-passengers, vehicles, and their horses and loads, to come upon the bridge at any one time exceeding 28 tons. The entire span from saddle to saddle is 702 ft. 3 in., and the height of the bridge —245 feet above high water—is, we believe, unequalled up to the present."

The Clifton Suspension-bridge is the most magnificent chain bridge ever constructed, and for strength and durability may be pronounced unequalled. In grandeur of appearance it is beyond all attempt at rivalry. The Queenston bridge, with its immense span of 1040 ft., does, indeed, exceed it in dimensions, but its effect is marred by its low position, and the roadway is only 20 ft. wide. The Fribourg bridge is by far the grandest in effect of all that have been enumerated, but even that is only 167 ft. above the river which it spans; while the Clifton Suspension-bridge, 245 ft. above high water, is unequalled in the world, and will ever be regarded as one of the grandest conceptions of Mr. Brunel.

In reply to the statement in the *Times*, that the Clifton Suspension-bridge is, though not the longest, yet the "longest and highest" suspension-bridge in the world, a Correspondent remarks:—"The meaning of the expression is not very clear, but I infer from the context that it is to be understood as follows:—If we multiply the number of feet of span of the various suspension-bridges by the number of feet of altitude above the waterway, the Clifton bridge will give the largest product. In this respect, however, it yields the palm to the Pont de la Caille, in Savoy, on the road between Geneva and Chambéry, which, although of rather less span than the Clifton bridge, is more than twice the height. Its dimensions are thus given in Murray's *Handbook for Switzerland*, &c.:—Length, 636 ft.; height, 656 ft."

When viewed from the river, or from Clifton Down, the chains of the bridge are more like threads than the substantial supports

of a bridge on which it is estimated 8000 persons might stand without the slightest danger to the structure.

WIRE SUSPENSION-BRIDGE.

In a paper read to the Institution of Civil Engineers, Mr. Mann has stated that, about 20 years ago, a French engineer, M. Vauthier, designed and erected a suspension-bridge on one of the main roads, across the river Capibaribe, at the village of Caxangá. The roadway, which was 100 ft. long by 20 ft. wide, was suspended from a pair of iron wire ropes on each side of the bridge, by vertical rods of wrought-iron, the attachment of the rods to the ropes being by means of strong wrought-iron plates, embracing both ropes. Each rope was in four separate pieces, and consisted of a mass of wires simply laid together, and bound at intervals. The rocking standards were of cast-iron, in three pieces, and the platform was of wood. All the work was executed in the country, including the casting of the standards, but the wire was purchased in England. The ropes, as well as the cast and wrought-iron work, were still sound. The cost had amounted to between 5000*l*. and 6000*l*.

THE ALBERT BRIDGE.

This new Bridge, about to be constructed across the Thames at Chelsea, from Cadogan-pier to the Albert-road, on the opposite bank of the river, is designed on what is known as the rigid suspension principle, in which the chains are so arranged as to render the roadway practically rigid. The greatest amount of deflection that can occur under heavy moving loads is scarcely appreciable, being only that due to the elasticity of the metal in the chains; and not in any way arising from a disturbance in the curve of equilibrium taken by the catenary, as is the case in the ordinary suspension principle, in which the platform, under a rolling load, assumes a curve, which assimilates itself to that of the altered catenary. The river piers will consist of cast-iron cylinders, of similar character to those generally adopted in bridges now being constructed over the Thames. These piers will be surmounted by cast-iron towers, of an ornamental character, and the superstructure of the bridge, consisting of the main and cross girders, chains, and vertical rods, &c., will be of wrought iron. There will be a clear waterway or centre span of 453 ft. 6 in., and two side-openings of 152 ft. 3 in. each. The roadway will be 26 ft. 6 in. in width, and the two footways, 6 ft. 9 in. each. The footways will not be divided from the road by the chains, as is the case in most bridges of this description; but there will be a clear width of 40 ft. between the parapet girders, with which the chains are connected. The engineers are Messrs. Ordish and Le Feuvre.—*Mechanics' Magazine.*

THAMES EMBANKMENT.

There are two different methods of foundation adopted in the two contracts for the Thames Embankment Wall: one, adopted by Mr. Ritson, is patented by Mr. J. S. Scott and Mr. Stockman. It is to sink cylinders—8 ft. diameter with 10 ft. spaces between them—into the clay; the cylinders are to be filled up, solid, with concrete, and upon them a massive and rigid system of cast-iron girders and plates, with caulked joints, is to be lowered in place complete, forming, as we term it, a "sealed platform." Round the margin of the platform there will be vertical sides and ends similar to those of an ordinary tank; and in the dry chamber thus formed the wall will be erected. When the portion of the wall enclosed is completed, the tank sides and ends will be removed and the wall remain, founded on and inseparably connected with the massive platform, the whole being supported by the solid and numerous pillars of concrete in cylinders sunken down into the clay.

ENORMOUS WEIGHBRIDGE.

A new Weighbridge has been placed by the Manchester markets committee, in Liverpool-road. The platform is 16 ft. 6 in. long, and 9 ft. wide, in one solid casting, and the machine is adjusted to weigh from 2 lb. to 70 tons. It has been tested up to 50 tons. The transferring lever is 25 ft. 6 in. long, and is made upon a new principle, as applied to weighbridges, being constructed of wrought-iron boiler plates riveted together in the proper form, after the manner of the modern tubular bridges. Its strength was demonstrated when the machine was tested with 50 tons, which remained on the platform 43 hours, and the deflection of the lever at that period was very slightly over the eighth of an inch at the middle of its length. The weighbridge was made for the markets committee by Mr. Thomas Steen, of Burnley. The foundations are cased with a space between each to lessen vibration from passing carriages; and, together with the machine-house, were erected from plans and under the direction of Mr. Lynde, the city surveyor.

BURSTING OF THE BRADFIELD RESERVOIR, SHEFFIELD.

At nearly midnight, March 11, the town of Sheffield and its neighbourhood suffered greatly by the Bursting of the Bradfield Reservoir, the water rolling a cataract down the valley into and through Sheffield, to the Don at Doncaster; when 250 persons were drowned in their beds, or in trying to escape, or crushed beneath the ruins of their dwellings. It is the conclusion of several eminent engineers, that the giving way of the reservoir at Bradfield was caused by water having got under the outside slope of the embankment, which either induced the bank itself or the foundation on which it rested to slip. But they considered the site of the Bradfield embankment to have been injudiciously selected—the strata consisting chiefly of millstone grit, but with loose friable shale in the deepest part, unequal in quality and dis-

located, with old land-slips in the vicinity, extensive faults in the strata, and with several strong springs of water which it was difficult to avoid. Other engineers are equally decided in their objections to the site; and state that the embankment was extremely faulty in its construction. Some half-dozen engineers of great experience expressed similar opinions; and all concur in stating that the embankment of a reservoir should be laid in layers of only a few inches in depth, which should be well "punned," or rammed; that the pipes were only 18 inches in diameter, and held to have been insufficient. A still greater defect was that the valves were on the outside of the embankment only. Thus there was no means of shutting off the water in the inside of the dam; whereas, if valves had been fixed on the inner end of the pipes, access could have been had to them when the reservoir was full. This arrangement is strongly commented on by the engineers. But perhaps the most important question touched upon in the professional Reports is that of the manner in which pipes should be laid from the reservoir to beyond the embankment. In the case of the Bradfield reservoir, they were laid in a trench under the dam. The engineers whose Reports the Sheffield Town Council publish are nine in number—Mr. Leslie, Mr. Stevenson, Mr. J. Murray, Mr. Conybeare, Mr. Lee, Mr. Barlow, Sir John Rennie, Mr. C. Vignolles, and Mr. M. B. Jackson; and several of them in unequivocal terms condemn that plan. Two of the engineers of the Water Company succeeded in obtaining results of a very important nature, which show that some of the theories set up by the Government engineer to account for the disaster must be excluded from further consideration. At the inquest on the victims of the flood, a great deal was said in condemnation of the manner in which the outlet pipes had been laid; and that Mr. Rawlinson, in his official Report, stated that "they were laid in a most objectionable manner, so as in fact to insure a fracture somewhere." This assertion was made the foundation for a superstructure of argument, more or less convincing, by critics who professed to be conversant with the subject, to show that the pipes, and pipes alone, had been the cause of the "failure." Mr. Rawlinson's assertions had the serious attention of many practical men, and the result was the institution of a set of experiments, which conclusively established the unsoundness of Mr. Rawlinson's theory, which was pointed out from the first in the *Mechanics' Magazine.*

Mr. Naylor has published an Analysis of Evidence on the failure. He is of opinion that the accident was caused by a land-slip taking place under the seat of a portion of the outer slope of the disastrous embankment. "We have had it declared," says Mr. Naylor, "that the bank was ample and the slope sufficient; we have had it proved beyond a doubt that the bank was composed of very porous material, rubble-stone specially selected to insure its being so, and for which threepence per yard extra price was paid until the embankment was raised 50 ft.; indeed, so porous

was it, that Mr. Rawlinson, on that particular ground, condemns it.

"Now, we have had more than 30 years of testing various substances in railway embankments, and we find that a bank of porous material, such as rubble-stone, does not slip; while, on the other hand, banks made up of impervious material, such as Mr. Rawlinson appears to recommend, have frequently given way, by one part sliding upon another.

"In carefully reviewing the evidence of this important question, and in coming to a conclusion as to the cause of the accident, it appears to me that the failure did not arise from any fault in the outlet pipes laid in the trench under the embankment, neither in the pipes breaking, nor from the jointing material being blown or forced out of the joints, nor yet from the water creeping along the outside of the pipes, nor from the pipes being drawn asunder: if any of these things had happened while the valves were shut, water must have been seen coming through the pipe-trench, and there is no evidence to show that such was the case. But, on the other hand, there is negative evidence that Mr. Gunsone did not notice any water escaping by the pipe-trench.

"The evidence in my mind is abundant to show that the fatal accident arose from a land-slip under the embankment outside the puddle-wall; for I do not believe that a bank composed of rubble-stone laid as described with a slope of two and a half to one, could slip except it was carried away upon a portion of the ground upon which it had been laid, by the slip taking place below the original surface."

Messrs. Simpson, Hawksley, Bateman, Fowler, and Harrison, the engineers appointed by the Water Company, dissent from the opinion of Mr. Rawlinson and Mr. Beardmore as to the cause which led to the rupture of the embankment. They state that there was no fracture of the pipes, and that the embankment was composed of materials which would not have slipped if the base on which it rested had been immovable. They say—"After a full consideration of the collateral circumstances, we are unanimously of opinion that the accident was occasioned by a land-slip, which occurred in the ground immediately on the east side of the embankment, and which extended beneath a portion of its outer slope, involving in its consequences the ruin of that portion of the bank, and producing the catastrophe which followed." The document is prefaced by a correspondence with the Home Office, in regard to the resumption of work on the Agden Reservoir, which was stopped by the Directors immediately after the accident at Bradfield. Sir George Grey declines further investigation by the Government, and curtly informs the Directors that he has no power to interfere with their decision to proceed with the Agden embankment, which, if done, must be upon the undivided responsibility of the Company, and without the sanction of the Government. The evidence of *five* engineers against two must not be overlooked.

PORTSMOUTH BLOCK-MACHINERY.

THE exhibition of the collection of Naval Models at South Kensington, in which is included the Block Machinery at Portsmouth, has led to the repetition of the statement that the same was invented by Sir Isambard Brunel, to which a Correspondent of the *Times* has replied :—

"Sir Isambard Brunel did not invent, nor did he ever claim to have invented, the Block-Machinery which he had a share in setting up at Portsmouth.

"The original invention, or series of inventions, was by two men, father and son, each named Walter Taylor, natives of Southampton.

"The beginning was rather more than a century ago, and was made by the father, who had been at sea, and had been practically impressed with the inefficiency of the blocks in use in his time. After a time they took out a patent for part of their inventions, and subsequently a second patent. These included friction wheels and circular saws, both of which we owe to the Taylors. During the continuance of their patents they, under contract, supplied the Government with blocks for the navy, and for some years theirs were the only blocks used in the Royal Navy. When, towards the close of the last century, their patents expired, they wished to obtain an extension of them, but the Government objected, and decided on setting up the machinery for themselves.

"Mr. Walter Taylor, the son, who was then making his blocks at the Wood Mills, South Stoneham, near Southampton, generously offered to the Government every facility for the purpose. The Government employed two clever young men to set up the machinery—one of whom was Mr. (afterwards Sir) Isambard Brunel, and the other Lieutenant (afterwards General) Bentham, R.E. With the benefit of Mr. Taylor's explanations these two young men examined his machinery, and then proceeded to set up machinery on the same principle at Portsmouth.

"Having the resources of Government to back them, they improved the details of the machinery, using for it steam power instead of water power, by which Mr. Taylor's mills were worked; but in every essential point the block machinery at Portsmouth is the invention of the Messrs. Taylor. General Bentham's share in the improvements has been forgotten as much as the Messrs. Taylor's original invention.

"Some years ago the specifications of the patents were printed in the *Builder* newspaper, and they will enable any one of a mechanical turn of mind who wishes to ascertain how far Messrs. Brunel and Bentham were indebted to the Messrs. Taylor, to do so easily.

"The originality of the invention was more than once publicly claimed for the Messrs. Taylor during the lifetime of Sir I. Brunel, and the claim was never contested by him or by General Bentham; although General Bentham's widow objected that too little credit had been assigned to her husband."

WOOD SAWING AND SHAPING MACHINES.

AN invention has been patented by Mr. J. W. McCarter, of Londonderry, and is described with engravings in the *Engineer*. It comprises improvements applicable to Machinery for Sawing Wood, and more or less to other wood-cutting machines. Deal frames upon his plan are sawing thirty-two deals per hour, two being cut at the same time. The invention does not relate to the saws with their frames and guides. The first portion of the invention relates to an improved silent feed-motion, the principal part of which is a disc fixed on a shaft driving the feed roller-shafts. A second portion of the invention relates to improved rollers for carrying, moving, and guiding the wood through the machine, these rollers

being so contrived as to dispense with the fence, side rollers, weights, and springs hitherto employed.

Another invention, by Henry Wilson, of London, is described as consisting in the construction of machinery whereby wood is shaped, either one piece or several pieces at one time, to the form of a metal or other suitable hard template or guide, by means of rotating cutters, which act upon the wood in the direction of the grain, whereby a smooth and even surface is obtained. These inventions cannot be fully described without the aid of illustrated engravings.

IMPROVEMENTS IN MANGLES.

MR. GEORGE ELLIS, mechanical engineer, Wellington-road, Bow, has patented an improvement which appears to embody all the qualities of a Mangle for regular family use. In the first place, it is adapted for every description of work, the rollers being large enough for full-sized sheets, and counterpanes, and are adjustable to suit the smallest articles. A mangle five times its size, weight, and cost, could not be more useful in this respect.

The work is done quickly. No time is lost in folding the linen in a cloth round the rollers; but each article is passed through singly, once or twice, backward and forward, and the next in succession, so that a large basket full can be done in half-an-hour.

The apparatus can easily be carried about by one person; it stands firmly upon a table when in use, and when done with can be lifted upon a shelf, or put into a cupboard.

The rollers are of polished sycamore, supported in a neat bronzed metal frame, and are actuated by a small winch and pinion. Every part is made both strong, light, and durable; and the construction being so simple, there is little danger of the article getting out of order.—*Mechanics' Magazine.*

SCALING LADDERS AND FOLDING DOORS.

MR. GEORGE FAWCUS has read to the British Association two papers, of which the following are abstracts. It is almost proverbially said that Ladders are never the right length when wanted. The longer they are the more liable are they to be broken. Various ways have been tried to remedy these inconveniences by joining ladders together: as, for instance, the military scaling ladders; the fire-escape; or the very common plan of lashing one over the other, as practised by masons, painters, and others. There was exhibited, in the International Exhibition of 1862, a method of fastening scaling ladders with dove-tailed and grooved bolts, the ends of each succeeding ladder fitting over cleats fastened on the side pieces. Now, in the Patent Museum, South Kensington, had been exhibited the model of a set of fire-escape ladders which had been presented to the Corporation of Tynemouth. These fastened together with (self-acting) steel spring catches, acting on iron clasps or hoops;

the ends of the side pieces well protected by iron plates on each side rivetted together, and some other improvements, as shown in the small model. There is now another simpler plan proposed, which it is thought may be made available for any kind of ladder. The ends of the steps are turned down, to form a shoulder to bear against the side pieces, the smaller parts of the step going through the side pieces, but not wedged into them. Under the upper and lower steps are iron tye-bolts, going across through the side pieces, the ends either turned down with projecting shoulders, like the wooden steps; or squared, and fitting through and against iron plates, neatly let into the wood; the ends of these bolts being screwed and fitted with neat nuts and plates, to screw up and bind the parts of the ladder together. The ends of the side pieces fit on to and overlap these bolts, and are further strengthened and protected by over edge-plates. In the middle of these screw bolts are placed open eyes in the shape of a horse-shoe. These eyes rest against the steps above, and form stops for lashings, or an iron connecting stay with a large eye, working round the top step and in the open eye of the bolt below; and with a bulb end dovetailing into the horse-shoe shaped opening of the bolt, under the lower step of the succeeding ladder, they will form a strong thrust and tie fastening between the ladders when joined. Two excentric circular plates (like the escutcheons of key-holes) turning down prevent the bulb-ended stay falling out of its socket on either side. These ladders are easily taken to pieces, either for repairing or close packing, as shown in the half of a ladder submitted to the Section for examination.

Many serious accidents happen to children by their hands and feet getting into the openings at the backs of Doors. Other persons sometimes are hurt by the shutting of the doors of railway carriages. It is now proposed to remove the possibility of this kind of accident, by a different plan of hanging the doors, viz., instead of the doors moving on hinges at the back, to make them revolve on pivots at the top and bottom of the door; the centre of motion, being at least half the diameter of the door beyond the back, and the space between being filled up by circular mouldings, which revolve with the door fitting into circular recesses, or the door revolving round them, the backs being grooved to a corresponding curve; the arrangement forming a rule joint, and presenting no opening in whatever position the door may be in.—*From the Bath Chronicle Report.*

THE ADYTIC LOCK.

In this Lock security against picking is sought and obtained, not by complication of the interior, but by absolutely closing the works of the lock from all observation, and from all manipulation with any picking instrument. In the first model the key or check is conveyed into the lock by means of a kind of slotted piston, which moves through a collar or bearing; which, being somewhat

longer than the slot, as a matter of course, cuts off all communication by means of any instrument used in an attempt to touch the works from the outside. In the second model, this object is still more effectually achieved by means of a secondary bolt, which, having in its centre a key-hole, or receptacle for the check, enables the same to be introduced to this inner key-hole, provided the latter be brought into coincidence with the outer key-hole of the front plate and door. In order that the check so introduced may pass into the lock itself, it is necessary to move the secondary bolt, which, at the same time that it conveys the check into the lock, also bolts up the outer key-hole, thus closing all access from without, even to the inner key-hole. This same secondary bolt can never be brought into such a position as to allow even an air passage to the lock, thus rendering gunpowder of no more avail than picks to effect an entrance. But, perhaps, the most novel and valuable feature in this new system of lockmaking is the certain retention of a false key or check on its first introduction.—*Worcester Herald.*

FACTITIOUS BLOCKS OF WOOD.

Gustave Colomb, a civil engineer, of Switzerland, has patented an invention for manufacturing Factitious Blocks of Wood of diversified shades or colours, intended especially to be divided by sawing into thin sheets for veneering, although the blocks can be applied to other purposes. The inventor takes shavings, made by hand-planing or by machine, which are rolled up by means of a spindle with crank, compactly on each other, to form bundles, several of which are closely packed in suitable frames. The bundles can be formed with shavings of the same kind of wood, or of several different kinds and colours: in some cases shavings of other thin and pliable substances are introduced; such as thin strips of soft metals, horn, whalebone, ivory, tortoiseshell, papier-mâché made of sawdust, and any substance capable of being glued together with the wood shavings. When the frame has been filled up with bundles of shavings, it is dipped in a hot bath of well-liquefied glue. After this immersion, the bundles are submitted to strong pressure, and the blocks thus formed are carried to a hot-air chamber, where they are sufficiently dried to be cut into thin sheets.—*Builder.*

THE PNEUMATIC LOOM.

Mr. Thomas Page, C.E., reports on a new system of weaving by compressed air in the Pneumatic Loom. The improvement will affect the working of nearly 500,000 power-looms, the labour of more than 775,000 persons, and the manufacture of about 1,200,000,000 lb. of cotton alone. The principle upon which the new loom acts is that of discharging a jet of compressed air from the valves of the shuttle-box, upon the end of the shuttle, at each pick or stroke, and thus substituting for the imperfect motion of the "picker" the

pneumatic principle, simply applied. The working velocities will be in the proportion of 240 strokes by the new machine per minute, to 180 strokes of the old in the same time. This improvement applied to the whole of the power-looms in the United Kingdom would represent a total increase of 1,400,000,000 yards over the produce of the same number of existing machines.—*Builder*.

THE IVORY TRADE.

FEW persons are aware of the immense demand there is for Ivory in our days. At the close of the last century, England did not work more than 192,600 lb. of ivory per annum; in 1827 the demand had risen to 364,784 lb., which supposes the death of 3040 male elephants per annum, yielding 6080 tusks, averaging 60 lb. each. At present, England consumes 1,000,000 lb. per annum, or upwards of three times the consumption of 1827; therefore the number of elephants killed for England alone must be 8333, or thereabouts. About 4000 men lose their lives annually in the pursuit after ivory—that is, to provide the world with combs, knife-handles, billiard-balls, &c. A tusk weighing 70 lb. is considered by the trade a first-class one. Cuvier made a list of the largest tusks found up to his time, and the most considerable one registered by him weighed 350 lb. At a late sale of tusks in London, the largest, brought over from Bombay and Zanguebar, weighed from 120 lb. to 122 lb. Those from Angola averaged 69 lb.; those from the Cape and Natal, 106 lb.; from Lagos and Egypt, 114 lb.; and from Gaboon, 91 lb. But these are by no means the largest sizes to be found at present; for elephant hunters now penetrate farther inward into Africa, and therefore meet with older animals. A short time ago an American house cut up a tusk which was not less than 9 ft. in length and 8 in. in diameter, and weighed 800 lb. In 1851 the same house sent over to the London Exhibition the largest piece of sawn ivory ever seen; it was 11 ft. in length and 1 ft. broad. The dearest ivory is that which is used for billiard-balls. There are several kinds of ivory: that which is brought over from the western coast of Africa, except Gaboon, is much less elastic than other sorts, and not so easily brought to perfect whiteness by the working; it is only used for knife-handles. Since the conquest of Algeria by France, the ivory trade has considerably increased in the north of Africa, which receives its supply from the caravans crossing the Desert. The hippopotamus also yields ivory, which is much harder and less elastic than that of the elephant, besides being of much smaller dimensions.—*Galignani*.

SUBSTITUTE FOR IVORY.

THE well-known billiard-table makers, Messrs. Phelan and Collender, of New York, announce their willingness to give 10,000 dollars for a suitable substitute for Ivory, to be used in the manufacture of billiard-balls. This statement has appeared in the *Tribune* journal, and the prize is well worth striving for; it is not often that such a liberal reward is offered for the discovery of a new and useful material. The great cost of natural ivory at the present time, owing to the high rates of exchange and its scarcity in general, is sufficient to warrant extensive experiments; for, should a substitute capable of being used for billiard-balls be found, it will not be confined to them, but will be available for a great variety of purposes.

WOODEN PAPER.

M. BARDOUX, a manufacturer of Poitiers, is said to have made a discovery which will effect a revolution in the manufacture of Paper. He has succeeded in manufacturing paper from various descriptions of timber, such as oak, walnut, pine, and chestnut, and from vegetables, without the addition of rags. Samples of various descriptions of paper are exhibited at the office of the *Journal des Inventeurs*. M. Bardoux asserts that his invention will cause a reduction of from 60 to 80 per cent. in the price of paper.

DISPENSING WITH THE STEEPING OF FLAX.

IT appears from the *Society of Arts Journal* that a French manufacturer named Bertin has invented what is reported to be a successful method of Dispensing with the Steeping of Flax. After the fibres have been crushed in the ordinary way, M. Bertin submits them to a new process, that of friction between two channelled tables, which have a sideway as well as to-and-fro motion; in fact, the action is similar to that of rubbing the fibres between the palms of the hands, but under considerable pressure and with great rapidity. The fibre is afterwards beaten in water, which carries off every particle of woody matter, and leaves the flax completely unbroken and in parallel masses. The principle of friction tables has been applied by M. Bertin in other cases, and is said to furnish an economical, rapid, and perfect mechanical action. The same inventor has adopted a new system of chemical steeping to get rid of the resinous and other matter which attaches the fibres together, which is said to produce the required effect in less than two hours, at a cost of about 1s. 8d. per cwt., leaving the flax nearly white; but the particulars are not given. By M. Bertin's system it is affirmed that the yield of flax is raised from 12 or 15 to 20 or 22 per cent. of the gross material.

Lastly, M. Bertin collects the refuse beneath his crushing machines, burns it in his boiler furnaces, and uses the ashes and the water in which the flax is steeped as manure; giving back, as he affirms, the whole of the mineral salts and azotised matter contained in the crop, besides saving the cost of so much artificial manure to the cultivator.

NEW PRINTING.

THE *Journal of the Society of Arts* states that a M. Leboyer, a printer of Riom, in the Puy de Dome, has recently patented a New System of Printing, in which the printing ink is replaced by black paper, prepared with glycerine and lampblack. The carbonized paper is extended over two cylinders, and is shifted at each impression so that the pressure of the types may not fall too often on the same parts. The black paper remains always slightly moist, and may be used two, three, or more times. The convenience of such a system, provided the result be satisfactory, is self-evident, and it is quite possible that it may be applicable for address cards—to which M. Leboyer has specially applied it—and to some other applications of the same kind. Whether it can ever supersede ink for general purposes is a more difficult question to resolve. A very similar invention had previously been brought before the public. In this latter case, however, the black medium was inclosed between two surfaces of white paper, one of which was broken by the type face, and the black permitted to show.—*Mechanics' Magazine.*

PRINTING IN COLOURS.

MR. H. E. KRAMER has patented certain improvements in Printing in Colours pictures or devices, to be used in ornamenting porcelain, stoneware, earthenware, or any other substances where the colours can be annealed, or melted, or burnt in.

The process which the patentee employs is as follows:—He uses in the production of the pictures, or devices, or designs, types made from good hard wood, or other substances adapted to the purpose, and such as are used by book printers. He then prepares the paper to enable it to receive and take up the colour, and reproduce it on the ware to which it is to be applied. He first presses the paper in a suitable glazing or other machine, in order that it may be perfectly flat; and he then washes it over with a well-made wheaten starch, or other suitable substance of a similar character, used ordinarily for similar purposes; when dry the paper is again pressed in the glazing machine, and then he places over it a thin coat of clotted oil of turpentine, or other oil, the use of which constitutes one of the improvements in the process of printing in which this invention consists, inasmuch as such coating of oil causes the paper to take up the colour better and more readily than when such coat is not employed, and enables a better-finished picture to be reproduced on the ware. The colours which he employs in producing these pictures or designs are all mineral; they are prepared by mixing them with a mixture of sticky oil of turpentine and oil of cloves. This mixture is similar to those used by china painters, but must be mixed stronger. The colour so mixed he applies to types by the rollers, which are by preference made from a substance consisting of the best syrup and good transparent glue. The printing types are placed in a printing press of ordinary construction, and are fixed in the right position by iron frames, one being employed with each of the types printed together. The process of applying the colour from the roller to the types, and the pressing, is similar to that adopted by book printers. One, two, or more colours may be printed at the same time, but in the case of valuable colours, such as gold colour or purple, he prefers to print each alone, to prevent any unnecessary waste of colour; the process of printing is repeated as often as is required, according to the number and the kinds of colours used. When it is finished the picture may be at once transferred on to the ware of the above-mentioned substances, and fixed in the way well known to the trade.—*Mechanics' Magazine.*

NEW ENGRAVING PROCESSES.

SOME curious experiments, executed before the Emperor and Empress of the French by M. Dulos, are thus described in *Galignani's Messenger*:—A sheet of copper, drawn on with lithographic ink, is subjected to the voltaic pile, by which it receives a deposit of iron on those parts not covered by the ink. The ink is then removed by means of benzine, and the sheet is then in the state of an engraved copper-plate—that is, the design is sunk into the plate, and the deposit of iron constitutes the lights. The plate is now dipped into a bath of cyanide of silver: under the action of the galvanic current, silver is deposited on the copper, and not on the iron. The plate is then taken out, and mercury poured upon it. Now, since mercury exercises no action on iron, it can only attack the silver which has filled up the lines originally made with lithographic ink. Hence, where those lines are, we now see mercury standing up in relief. Plaster of Paris is now poured over the plate in this condition, and thereby an impression is obtained in which the reliefs made by the mercury are reproduced hollow. [Why the ink was removed, or silver deposited, in this case, is not clearly stated.] By the aid of the pile, copper may be deposited on this impression, and the hollows will then come out again in relief. One thus obtains not only a plate which may be printed from, but a matrix which will give an indefinite number of plates. For typographic engraving, the sheet of copper, after being drawn upon, receives a coating of silver, which only goes upon the metal, leaving the lithographic ink untouched. The ink is removed, as before, by benzine. The surfaces which are thus laid bare are oxydised, and mercury is again poured on the plate. This metal recoils from the oxydised lines, and collects on the silver, making reliefs where the lights ought to be. An impression in plaster is obtained as before, and the electro-chemical plate which is to be used for the printing has the lines of the drawing in relief as required.

NEW INKS.

MR. FRIEDERICK has patented the manufacture of a New Ink, of which the following is the method:—Say for one gallon, take six quarts of boiling water, and while in that state add of logwood 2lb. (avoirdupois weight), and allow it to boil until reduced to one gallon of liquor; then take of bichromate of potash three drams twelve grains and of ferrocyanide of potash one dram thirty-six grains (troy weight), previously dissolved in sufficient water, and mix the whole together; then boil up, and when cool strain carefully through flannel, and the ink will be fit for use.

In a German journal is described a new indestructible ink, said to be composed of twenty grains of sugar dissolved in thirty grains of water, to which are to be added a few drops of concentrated sulphuric acid. Upon heating this mixture the sugar becomes carbonized by the acid; and when applied to the paper it leaves a

coating of carbon which cannot be washed off. This stain is rendered more permanent by the decomposing action of the acid itself upon the paper, and when thus made it resists the action of chemical agents.—*Builder.*

NEW POSTAGE STAMPS.

A NEW style of Postage Stamp has been patented in New York, the inventor of which claims that it cannot be fraudulently used twice. The body of the stamp is made of gold-beater's skin (instead of paper), which is tough and so nearly transparent that the printed impression on it shows almost as well on one side as on the other. The design, the legend, numerals, &c., are intended to be read through from beneath, and are therefore printed in reverse. The ink is also of a peculiar description. When this stamp is wet and glued on the letter, it remains permanent and unchanged, until some person attempts to peel it off. He then finds that the printed matter remains attached to the letter, while the gold-beater's skin comes off quite colourless.

SUBSTITUTE FOR GUTTA PERCHA.

M. SERRES has described to the French Academy of Sciences the *Valata*, a shrub which abounds in Guiana, and affords a juice which he asserts is superior, for many purposes, to gutta percha, but especially as an insulating material for enveloping telegraphic wires. The milk or juice is drinkable, and used by the natives with coffee. It coagulates quickly when exposed to the air, and almost immediately when precipitated by alcohol, which also dissolves the resin of the *Valata* juice. All the articles made with gutta-percha can be made with the sap of the *Valata*, and it has no disagreeable smell. When worked up it becomes as supple as cloth, and more flexible than gutta percha. M. Serres exhibited a number of articles manufactured of *Valata* milk.

INDIA-RUBBER MANUFACTURE.

THE manufacture of toys, belting, and water-hose is carried on upon a large scale by the New York Rubber Company, in their factory at Wiccapee, situated in a romantic dell on Fish Creek, near the Hudson River, in Dutchess County. The various operations, of grinding, mixing, calendering, moulding, vulcanizing, and finishing the various products, are here seen to advantage. The rubber is first ground, or rather kneaded, between large iron rollers, and during this operation it is mixed with other substances, such as white lead, &c. It is here reduced to sheets, resembling bakers' dough, which are afterwards submitted to a "calendering" action—that is, they are pressed between large, heavy, polished iron rollers. Several machines having three rollers, placed one above another, are used; and one has four rollers, between which the mixed rubber is passed three times, and reduced to beautiful, smooth, and thin sheets. From such sheets

the several parts of hollow dolls, balls, globes, &c., are stamped in dies; then the parts are united with rubber cement, trimmed, and fitted into metallic flasks of different patterns; and next placed in batches in a large horizontal iron oven, where they are submitted to the action of steam of about 240 deg. Fahr. for five and a half hours. The articles are secured upon a carriage, and moved upon a railway into the oven, one end of which opens and closes, forming a large man-hole. After the goods are vulcanized, they are finished and painted.

The high price of leather has caused much attention to be devoted to the manufacture of some suitable substitute for it in large beltings; and success has been attained with India-rubber combined with strong flax-duck made for the purpose. The fabric is woven in looms, and several plies of it, stitched together by machines, are cemented with India-rubber and then cured by solar action. We were told in the factory that India-rubber belting, cured by vulcanization, is not so durable, owing to the strength of the flax-cloth body being impaired by the high steam heat. One belt, 3 ft. in width and 252 ft. in length, weighed about 1600 lb., and cost from 1800 to 1900 dols. It was made for the driving belt of an elevator at St. Louis; and another of the same size, for a similar purpose, has been ordered for the Milwaukee and St. Paul Railway. This belting is composed of five plies of stout flax-duck, and it has twenty-seven rows of stitching in it. A very large business in manufacturing such belting is now carried on at this place; orders for nine belts, each 22 in. wide and 269 ft. in length, were being executed at the time of the writer's visit.

India-rubber hose are made of strong flax-duck, which is woven here in tube form, in looms adapted for the purpose. After coming from the loom, the flax-duck hose, of a certain length, is laid upon a long table and wrapped around on the outside with a layer of India-rubber in a sheet. This is cemented to the duck, and is to form the inside of the hose. A long iron rod is now thrust through the inside of the hose and hooked at the back end. The hose is now drawn over this rod by a reel, and turned inside out like a stocking, after which another layer of sheet-rubber is laid and cemented upon the outside, thus forming a perfectly close hose, water-tight inside and out, without a rivet from end to end. Of course, such hose is far stronger than that made of leather.—*American Artizan.*

SEWING-MACHINES.

"IN poverty, hunger, and dirt," Elias Howe, a native of Massachusetts, surrounded by a young family, for whom he was obliged to labour during the day, devoted his after hours to the construction of a Sewing-machine. This was about the year 1841. After incessant labour, during the latter part of which he and his family were indebted to a friend for the means of existence, he completed the first working Sewing-machine, the patent for which was granted

to him in May, 1841. Singularly enough, the American public did not see the merit of the invention; and poor Howe, after making over one-half of his patent to his friend for the assistance afforded to him, determined to try his fortunes with his machine in England, acting in the belief that a man is no prophet in his own country. It would appear, however, that he was treated only as a minor one in this; for, after attempting in vain to get his invention favourably appreciated in London without effect, he was at last constrained to sell his patent, and the machine itself, to Mr. Thomas, of Cheapside, who immediately saw the applicability of the machine to his own manufacture—that of stay and corset making. The sum of 250*l.* was all that Howe got for his incomparable invention, which was destined to make the fortunes of thousands, and to confer a benefit upon large classes of the people scarcely second to any that has appeared during the present century.*

Finding that he could do no good for himself in this country, and falling into bitter poverty, he determined to return to New York, and when he did so he had the mortification of finding that in his absence his patent rights had been infringed, and his invention pirated, by wealthy people, who were determined to throw the whole weight of their means into the scale in fighting Howe's right to his own invention in a court of law. The trial which followed demonstrated, in the clearest manner, that to Howe, and to him alone, belonged the credit of inventing the first Sewing-machine. Others, it is true, had tried to do what he had accomplished, but failed; and an Englishman may fairly take the credit of going within an ace of the invention, without knowing how near he was to fame and fortune. We allude to the machine invented by Mr. John Fisher, of Nottingham, for the purpose of ornamenting lace, and patented in June, 1845, a year previously to that of Howe's. This machine did, indeed, interlock threads in the same manner as Howe's, by means of an eye-pointed needle carrying a loop of thread through the material, which was traversed and fastened on the under side by a shuttle; but here the similarity between the two inventions ended. Mr. Fisher was intent upon a lace embroiderer, which he accomplished in a most ingenious manner; but he really had no claim to the invention of a sewing-machine, although some years later, by a few additions, this very embroidery-machine was made to sew. In 1858, when the merit of the American instrument was becoming well known, Mr. Fisher endeavoured to obtain an extension of his patent, which had been allowed to lie dormant for many years, on the plea that he had not

* Mr. Newton, of Chancery-lane, however, writes to the *Times*, "That the invention was brought to this country by the brother of the inventor, and that Mr. Thomas was the only person to whom the invention was offered. Mr. Thomas did not purchase the patent for the sum named, but the right to patent, which in this case made a difference in favour of the inventor of 166*l.* 7s. 6d., that being the sum paid for obtaining the English patent. Moreover, the purchase of the invention was accompanied by an offer sufficiently remunerative to induce the ingenious inventor to visit England and work for some two years at Mr. Thomas's expense in adapting his mechanism to special uses. Thus much of explanation is, I think, fairly due to Mr. Thomas."

time to perfect his machine; but the Court refused his application: indeed, this attempt to turn an embroidery-machine into a sewing-machine was only an afterthought, brought about by Howe's success. The essentials of a sewing-machine, to use the language of one of Mr. Howe's advocates, may be divided into three parts:—

"1. A mechanism for making stitches, or interlocking of thread, in combination with an apparatus for making tension on the thread and drawing up and duly securing each stitch when formed.

"2. An apparatus consisting of two surfaces, between which the material to be sewn is contained, and which support it against the thrust and retraction of the needle, and in such a position as to permit the stitches to be drawn tight.

"3. An automatic, intermittingly feeding apparatus, which causes the material to progress with a regular, uninterrupted movement, between the holding surfaces in the intervals between the successive punctures of the needle, with an unerring, absolute precision, and uniformity of effect impossible to obtain by hand."

Howe was the first inventor who combined these movements in one machine, and to him, without doubt, is due the credit of bringing it into practical use. The public are so familiar with the apparatus, consisting of an iron arm and an arrangement of parts at its extremity which almost rivals the human hand in deftness, that we need not enter into any particulars as to its appearance or mode of operation, further than to say that Howe's original machine contains the germ of the numberless patents that have appeared since his was taken out; and that in consequence every American sewing-machine exported to this country pays a royalty to him of one dollar for that right, and a royalty is also exacted for home use. The method by which the stitch is made by the various machines now in use, and the character of the stitch itself, vary very much. The majority of these sewing-machines make what is called the lock-stitch—by far the most durable method of sewing. In order to accomplish this a loop of thread is thrust by the eye-pointed needle through the material to be sewn. This loop is threaded by a shuttle, which traverses backwards and forwards on the upper side of the material. By these means the thread is made to interlock within its substance—a very important feature, inasmuch as the fastening of the thread is protected from the friction of wear and washing. All machines used in trade where strength of sewing is required make this stitch; indeed, cloth and leather work would not bear the loop-stitch fastening, which is made outside of the material sewn, and forms a ridge very liable to be worn away. Howe's, Thomas's, and Singer's powerful manufacturing machines make the lock-stitch. There is also another machine which works it, but in a different manner. The Wheeler and Wilson machine, which is the one best calculated for household work, makes the lock-stitch by means of a rotating hook, which interlaces the thread on the under side, and does away with the necessity for the shuttle, which is unnecessarily noisy in the drawing-room or boudoir. There are other machines which substitute a looper for the shuttle, and make a single thread

loop-stitch, which is apt to unravel. It seems to us that a good single-thread machine which would imitate hand-sewing, which for all ordinary purposes is quite firm enough, is yet a *desideratum*, inasmuch as such a contrivance would necessarily be more simple than a machine sewing with a double thread, and would economise its use. Some of the sewing-machines are very extravagant in this respect, one of the most noted of those making a double loop chain stitch using five yards of thread to one of sewing. This is a serious matter, looked upon in a manufacturer's point of view, where the great aim is to economise the material. The sewing-machine proper does nothing but plain stitching; but there are several ingenious appliances for hemming, tucking, and binding, the invention of M. Chapin, a Frenchman. "By this mechanism the machine prepares its own hem, and stitches it at the same instant, lays and sews simultaneously the binding on the edge of any material, and plaits tucks of an almost flounce width, sewing them with mathematical regularity and precision." Everything, in short, that the most cunning sempstress can do with her needle the machine can do vastly better and quicker—with two exceptions, namely, buttonhole making and sewing buttons on, and we hear that the former will soon be an exception no longer.

The sewing-machine has everywhere improved instead of lowered the wages of needlewomen. It has practically rendered Hood's sempstress "with fingers weary and worn" a thing of the past. No woman working at it earns so little as 5s. a week, which with the common needle would have been high wages, and they no longer labour for such a pittance 16 hours a day. In the various factories where it is employed 10 hours a day is the average time of labour. But recruits for the hands employed upon delicate machinery must be trained to be effective, and it is this preliminary training which is the great want. In the United States, where the sewing-machine has become a domestic institution, young girls when at school are trained to its use; possibly it may be so with us when the machine becomes more widely known. We understand that at the Needlewomen's Institution, Hinde-street, Manchester-square, two or three machines are introduced for the purpose of employing female labour; and at the Institution for Teaching the Blind, in New Oxford-street, they are also employed to teach sewing to those who have lost their sight. This is all very well, and it is pleasant to know that the blind can sew with the machine as well as those who can see; but, as we have said before, it is not employment for labour that is required, but a school of instruction in the use of the new machine which is fast supplanting the old needle. What is wanted is a training establishment, in which the machines of all the patentees in general use may be taught gratis.—*Abridged from the Times.*

TATTERSALL'S.—NEW BUILDINGS, KNIGHTSBRIDGE.

THE following details are from the description of these new premises in the *Builder*:—The central entrance leads onwards

through a tall iron gateway, over a granite tramroad, for heavy traffic, into the principal public yard, 108 ft. long by 60 ft. wide, for sales by auction. In the centre of this area will be found the old and familiar temple of the other premises at Hyde Park-corner, with its Fox, and the bust of George the Fourth, when young, at the top, and in the north-west corner the pulpit of the auctioneer. The whole of this yard is covered by a roof of Hartley's Patent Glass, 150 ft. in length, 102 ft. in breadth, and 60 ft. high. It is supported on iron girders, and constructed to admit or exclude at pleasure the external air, and thus obtain the greatest amount of ventilation. Surrounding and opening into this enclosure are some of the stalls and loose boxes. Behind the north and west portions of this inner row of stalls is a wide roadway, upon the sides of which, entirely free, are loose boxes, some of them for entire horses, and mares with their foals; the dimensions of these are 12 ft. by 14 ft. These are lighted by a ventilating louvre-top, to which all foul air is at once carried without retardation by the form of the sloping roof. The doors are likewise provided with the means of additional light and ventilation. All the divisions of the stalls are boarded up to 5 ft. 6 in. in height with elm planking, and have iron cappings. A system of trapping the drains, rendering each independent of its fellow, is likewise observable in these divisions. There are numerous corn-rooms, hay-lofts, washing departments, gas and water to each stall, &c.; the manure-pits are arched over, and effluvium is carried aloft by shafts. Above the inner square of stables, and equally beneath the protection of the glass roof, is a gallery running the entire length of the oblong square, for the repository of carriages. Under a portion of this gallery the tramway terminates in a turn-table, upon which the carriages rest, and are raised and lowered upon it to or from the upper lever by Easton and Amos's hydraulic apparatus, which is set in motion by simply turning a tap, the machinery being similar in principle to that now used at the monster hotels.

NEW MANURE.

A DISTINGUISHED French chemist, M. Boutin, after numerous experiments, has discovered, it is said, a New Manure, found to be of great value and efficacy, combining in its application economy of time and money. Being convinced of the great importance of the discovery, M. Boutin addressed a memorial to M. Rouher, Minister of Agriculture, who appointed a commission to make inquiries and experiments on the subject. The report of the commission, which speaks in very favourable terms of the new manure, states that the wheat sown with it, compared with that produced on land where other manure was used, presented a good appearance, the stalks being thicker and closer, and the ears full and abundant. The effects produced by the manure are stated to be complete exemption in crops of cereals from black, rust, or

smutty grains; that potatoes sown with it have never been diseased, and that the constant use of it does not in any way deteriorate the soil. In addition to the favourable report of the commission, a number of extensive agriculturists and landowners in France have expressed a high opinion of the manure as a powerful fertilising agent. A branch depot for the sale of it has been established in London.

UTILIZATION OF SEAWEED.

A PAPER has been read to the Philosophical Society of Glasgow by Mr. E. A. Wünsch, "On the Utilization of Seaweed," illustrated by chemical tables and specimens of plants. He took a rapid glance at the statistics of "kelp," the production of which is now about 10,000 tons per annum, but could be almost indefinitely increased if the difficulties of climate in the drying process could be overcome. The supply of seaweed on our shores is practically inexhaustible, being estimated by one authority at 21,000,000 tons per annum; while the present consumption, both for kelp and for green manuring, does not reach 1,000,000 tons. The wrack cast up on our shores during the winter season is by far the largest in quantity and the most valuable in quality, and is now proposed to be saved and dried artificially by a contrivance for burning "wet fuel," by which the seaweed itself is made to contribute towards the heat required for drying large quantities of it at a cheap rate, at all seasons of the year. Other mechanical appliances for largely increasing the present supply were suggested.—*Mechanics' Magazine.*

SINKING ARTESIAN WELLS ON THE CONTINENT.

MR. G. R. BURNELL, F.G.S., in a paper read by him to the Institution of Civil Engineers, stated:—

There were three different systems of well-boring, mostly dependent on the nature of the tools: the Chinese, or M. Fauvelle's the French, or rather, the usual well-borers' plan, and M. Kind's. In the first, the motion given to the tool in rotation was simply derived from the resistance that a rope would exercise to an effort of torsion, and therefore the limits of application of the system were only such as would allow the tool to be safely acted upon. Besides, a considerable quantity of water was required to clear out the boring, so that this plan had been almost universally abandoned. In the ordinary system of well-boring, the weight of the tools and of the solid iron rods became so great, when the excavation was deep, that there was considerable difficulty in transmitting the blow of the tool, in consequence of the vibration produced in the long rod, or in consequence of the torsion. Hollow rods, filled with cork, and M. Ænyenhausen's joint, which permitted the tool to fall freely, and through the same height, every time it was released, were now employed. M. Kind adopted both these

modifications, and in the well of Passy, he substituted oak rods for iron ones, as being lighter, and more easily counterbalanced in water. The products of the excavation were still most frequently removed by augers and chisels; and all the processes hitherto practised were considered to be more or less defective, as in every case the comminuting tool had to be withdrawn. In the well at Passy, M. Kind employed a trepan to comminute the rock; it weighed 1 ton 16 cwt. and fell through 2 ft. This tool was composed of two principal pieces—the frame and the arms—both of wrought iron, but the teeth of the cutting part were of cast steel. The frame had at the bottom a series of holes, slightly conical, into which the teeth were inserted, and were tightly wedged up. These teeth were placed with their cutting edge on the longitudinal axis of the frame that received them; and at the extremity of the latter there were formed two heads, forged out of the same piece with the body of the tool, which also carried two teeth, placed in the same direction as the others, but which were made of double the width of the latter, in order to render this part of the tool more powerful. It was by increasing the dimensions of these end teeth, that the diameter of the boring could be augmented, so as to compensate for the diminution of the clear space by the tubing that it might be necessary to introduce in traversing strata disposed to fall in, or to allow the waters from below to escape at an intermediate level. Above the lower part of the frame of the trepan was a second piece, composed of two parts bolted together, and made to support the lower portion of the frame. This part of the machinery also carried two teeth at its extremities, which served to guide the tool in its descent, and to work off the asperities that might be left by the lower portion of the trepan. Above this again, were the guides of the machinery properly speaking, consisting of two pieces of wrought-iron arranged in the form of a cross, with the ends turned up, so as to preserve the machinery perfectly vertical in its movements, by pressing against the sides of the boring already executed. These pieces were independent of the blades of the trepan, and might be moved closer to it, or further away from it, as might be desired. The stem and the arms were, lastly, terminated by a single piece of wrought iron, which was joined to the frame by a kind of saddle-joint, and was kept in its place by means of keys and wedges. The whole of the trepan was finally joined to the great rod that communicated the motion from the surface, by means of a screwed coupling, formed below the part of the tool that bore the joint, which permitted the free fall of the cutting part, and united the top of the arms and frame of the rod.—*Proceedings of the Institution.*

MECHANICAL PROPERTIES OF THE ATLANTIC TELEGRAPH CABLE.

MR. W. FAIRBAIRN has read to the British Association a paper on this inquiry. It appears that the Atlantic Telegraph Company, considering it essential to the public interest that the second at-

tempt to submerge a Telegraph Cable across the Atlantic should not be left to chance, and that a close and searching investigation should be entered upon, and that nothing should be left undone that could be accomplished to ensure success, sought the advice of a Committee composed of men of eminence and experience in the various branches of science and engineering involved in such an undertaking, to advise the company in the selection of a cable. For the satisfactory attainment of this object it was considered necessary, in the first place, To determine, by direct experiment, the mechanical properties of cables submitted for submergence in deep water; 2nd, To ascertain the chemical properties of the insulator, and the best means to be adopted for the preservation and duration of the cable; and 3rd, To determine the electrical properties and conditions of the cable when immersed, under pressure, at great depths. On the author of the paper devolved the duty of undertaking the first division of the inquiry, viz., to determine, by actual experiment, the strengths, combinations, forms, and conditions of every cable considered of suitable strength and proportion to cross the Atlantic. A laborious series of experiments was instituted; and, in order to attain accuracy as regards the resisting powers of each cable to a tensile strain, they were broken by dead-weights, suspended from a crab or crane, by which they could be raised or lowered at pleasure. The weights were laid on 1 cwt. at a time, and the elongations were carefully taken and recorded in the table as each alternate fourth hundredweight was placed on the scale until it was broken. By this process the author was enabled to ascertain with great exactitude the amount of elongation in 7 ft. 6 in. The result of the investigation was the selection of the cable of Messrs. Glass and Elliott, which stood highest in order of strength. In this inquiry, upwards of forty specimens of cables were tested in their finished state, and this might have been sufficient for the committee to determine the best description of cable; it was, however, deemed advisable to investigate still further, not only the cable as a cable, but to test experimentally each separate part, in order that every security should be afforded as to the strength and quality of the material to be employed in the construction.

With regard to the covering wires constituting the principal strength of the cable, Mr. Fairbairn finds that with proper care in the selection of the material in the first instance, a judicious system of manipulation in the second, and a rigid system of inspection of the manufacture, a wire of homogeneous iron ·095 inches diameter can be made of strength sufficient to sustain from 900 to 1000 lb., with an elongation of ·0068, or 68-10,000th parts of an inch per unit of length. This description of iron appears to be the most suitable for the Atlantic cable, as it combines strength with ductility, and may be produced at a comparatively moderate cost. It was also found desirable to test the separate strands of each cable as well as the wires themselves. For this purpose a number of strands similar to those employed in the manufacture of the different cables were produced, and the tensile breaking strain and elongations carefully observed and recorded. In order to ascertain whether the length of the lay of the hemp and Manilla round the strand was of that spiral form which produced a maximum of strength, the yarn separated from the strand was also tested, and comparing the sum of the breaking strains of the wire and yarn separately, with that of the two in combination in the strand, the object by these means was approximately obtained. Another very important question arises in the construction of this cable, and that is, the strength of the core and its conducting wire, and how it is to be protected under a pressure of 7000 lb. to 8000 lb. per square inch, when lodged at the bottom of the ocean. This appeared a question well entitled to consideration, and, provided a properly insulated wire, of one or more strands, can, without any exterior covering, be deposited with safety at these great depths, it is obvious that the simpler the cable the better. Assuming, therefore, that gutta-percha is the most desirable material that can be employed as an insulator, it then resolves itself into the question, what additional covering and what additional strength is necessary to enable the engineer so to pay out of the ship a length of 2600 miles, into the deepest water, as to deposit it, without strain, at the bottom of the ocean? This is the question the committee had to solve, and for this very important object experiments were instituted.

Regarding the circumstances bearing directly upon the ultimate strength of the cable, the committee have arrived at the conclusion, that the cable No. 46, composed of homogeneous wire, calculated to bear not less than from 850 lb. to 1000 lb. per wire, with a stretch of five-tenths of an inch in 50 inches, is the most suitable for the Atlantic cable. The following is the specification of No. 46 cable:—The conductor consists of a copper strand of seven wires (six laid round one), each wire gauging ·048 (or No. 18 of the Birmingham wire-gauge), the entire strand gauging ·144 inch (or No. 10 Birmingham gauge), and weighing 300 lb. per nautical mile, imbedded for solidity in the composition known as "Chatterton's compound." The insulator consists of gutta-percha, four layers of which are laid on alternately, with four thin layers of Chatterton's compound, making a diameter of the core of ·464 inch, and a circumference of 1·392 inches. The weight of the entire insulator is 400 lb. per nautical mile. The external protection is in two parts. First, the core is surrounded with a padding of soft jute yarn, saturated with a preservative mixture. Next to this padding is the protective covering, which consists of ten solid wires of the gauge ·095 inch, drawn from homogeneous iron, each wire surrounded separately with five strands of Manilla yarn, saturated with a preservative compound; the whole of the ten strands thus formed of the hemp and iron being laid spirally round the padded core. The weight of this cable in air is 34 cwt. per nautical mile—the weight in water is 14 cwt. per nautical mile. The breaking strain is 7 tons 15 cwt., or equal to eleven times its

weight per nautical mile in water—that is to say, if suspended perpendicularly, it would bear its own weight in 11 miles depth of water. The deepest water to be encountered between Ireland and Newfoundland is about 2400 fathoms, and 1 mile being equal to 1014 fathoms; therefore $1014 \times 11 = 11{,}154$, and $2400 = 4 \cdot 64$: the cable having thus a strength equal to 4·64 times of its own vertical weight in the deepest water.

Capt. D. Galton wished it to be clearly understood that the duty of the committee was to select the most suitable from those sent in to the company. It was no part of their business to devise a form of cable. In reply to a question from Mr. F. Jenkin, Mr. Fairbairn stated that in taking in elongations, care was taken to prevent untwisting. Capt. Selwyn objected to a spiral covering combined with a straight internal wire as incompatible with security from disruption. Mr. Hawkshaw said no one would dispute that Capt. Selwyn was right in principle. The question was, could it practically be carried out? The best form of cable had not yet been arrived at. The failures, however, in the Malta and Alexandria cable, which he had examined, did not arise from the spiral and longitudinal combination, but from a chemical action on the iron covering, the wires presenting the appearance of corrosion, as if by an acid. No coating of iron would last in such a situation, and the only remedy was to lay the cable wire in such a covering in another situation where such a corrosive action did not take place. It was no matter of surprise to him that the first Atlantic cable failed. A cable constructed as that was must fail. He and other engineers had previously told the Company that such must be the case.

At the time we write (Jan. 12, 1865) preparations were in progress on board the *Great Eastern* steamship, in the Medway, for the shipment of the first portion of the Atlantic telegraph cable. Its entire length is about 2500 miles, for the reception of which three enormous tanks were in course of erection on board the *Great Eastern*, each capable of holding about 800 miles of cable. In order to provide the necessary space for the stowage tanks, one of the principal saloons had been removed and two of the decks taken away, besides other alterations. The tanks have a diameter of 58 ft., and are 20 ft. in height; they are constructed of iron. According to existing arrangements, she will not leave the Medway until June next, so as to obtain the finest weather during the operation of submerging the cable. An ingeniously contrived machine has been constructed at the Company's works for paying out the cable, so as to prevent any accident from breakage while the steamer is under weigh. Her Majesty's frigate *Iris* is to assist in conveying the cable from the Thames to the *Great Eastern*.

NEW HYDRAULIC MOVER.

The mass of water which will shortly be at the disposal of Paris in consequence of the great hydraulic works now in progress

—a mass which will not fall short of 400,000,000 litres per day, situated at an altitude sufficient to raise it to the tops of the highest edifices in Paris—has suggested to M. Edoux, a civil engineer, the possibility of turning to a profitable account for the raising of weights the immense hydraulic pressure which may be derived from water at such an altitude. This pressure is evidently distributed throughout the capital with the liquid itself, so that every waterpipe may be made to supply this moving power at any particular point required. This premised, M. Edoux's apparatus will be easily understood. It consists of twin towers built of timber, and rising to a somewhat greater altitude than that to which a given weight is to be raised. Let us suppose a public monument, for instance, in course of construction; the towers will be erected close to the site, and furnish the building materials at a small expense and with great economy of time by the following process:—Two prismatic platforms or stages slide alternately up and down in vertical grooves made in the sides of the towers; each platform rests on a reservoir of water, which balances the weight to be raised, the bottom of each of these reservoirs being provided with a self-actingpeg valve, while an endless chain and a combination of sheaves serve to keep the platforms suspended at the proper altitudes. Now let us suppose one of the platforms to be on a level with the ground, just above one of the communications opened with a waterpipe, while the other platform is situate at the height which the building has reached. The lower platform receives the building materials, which are then more than balanced by admitting a quantity of water into the upper reservoir. No sooner is this effected than the lower platform will begin to rise, while the upper one with its heavy reservoir will descend in the same proportion. The materials thus arrive at the point where the building is going on, and while the materials are being discharged above, a new lot is put upon the empty platform. The loss of power by friction and other causes in this contrivance does not exceed 5 per cent.—*Galignani's Messenger.*

ON TORPEDOES AND RAMS.

Admiral Sir E. Belcher has read to the British Association a communication from Capt. Doty, of the Confederate States Navy, "On the Torpedoes used by the Confederate States in the Destruction of some of the Federal Ships of War, and the Mode of attaching them to the Rams." The Torpedo consists of a shell filled with explosive material, whether gunpowder or gun-cotton, and is carried under the surface of the water at the end of a bar attached to the stern of the ram or other vessel, projecting some ten or twelve feet. The bar has a slight sliding motion, by means of which the end of the bar within the vessel, as soon as the torpedo strikes the enemy's ship, acts on a simple mechanical arrangement, bringing the wires connected with the torpedo into circuit with a galvanic battery, causing the explosion of the shell.

Such an engine of war, Capt. Doty states, having been attached to small wooden steamers, an attack was made by it against the Federal frigates New Ironsides and Minnesota, and so much damaged them by the explosion as to render them unfit for further effective service, till docked for repairs. It was also employed in like manner against the new sloop-of-war, Housatonic, attached to the Federal blockading squadron off Charleston, which ship filled, and went down in eight minutes after the explosion of the torpedo under her counter. It is unhesitatingly asserted, by competent judges, that a vessel properly constructed for the use and application of the torpedo battery, and possessing superiority of speed, would prove a formidable antagonist against a number of frigates, armed with the heaviest metal, for it would, by advancing end on, present the least surface to their fire, and always under the most acute angles. An especial advantage which it possesses is, that it may be worked at all times; for instance, in a rough sea, when ordinary guns could not be used, while it may be employed with certain success, under cover of darkness, against an enemy's fleet, destroying, disabling, or driving them away from the coast altogether. Great economy, simplicity, and safety are, further, among the valuable and important qualities claimed for the submarine battery; neither the battery itself, nor the men working it, are in the least exposed, the apparatus being situated much below the line of flotation. Admiral Belcher proceeded to point out the superiority of such an engine of warfare over Rams. A ram with a velocity of 10 knots overhauls and touches the stern of the vessel she chases, going at the rate of $9\frac{1}{2}$ knots—a half-knot velocity would not injure her opponent, although it might impair her steerage, and bring her broadside to operate on her, in all probability, at such close quarters, to her detriment. But a ram fitted with the means of projecting a simple shell under the counter, or into contact with the screw, would inevitably destroy, or at least so derange rudder and screw, that her great work of executing the ram manœuvre at right angles to her antagonist would no longer be matter of doubt; and surrender would, under such difficulty, doubtless result. The French and other foreign governments have approved of the plans of Capt. Doty. Our own Government ordered the examination of them by a scientific committee, and it has expressed approbation in an official communication.

Capt. Selwyn pointed out how valueless would be our system of armour-plating our vessels, which only extended six feet below the water-line; and he advocated the importance of small twin screw-boats as preferable in every way to large vessels.

Mr. W. Fairbairn stated that the experiments of the Iron Plate Committee were now brought to a close, and the results were recorded in four Blue Books. The conclusion he arrived at from these experiments was, that no ship can be made to carry plates sufficient to withstand our guns, and it would probably be better to have no plating at all.

Natural Philosophy.

ROYAL SOCIETY MEDALS.

The Copley, Royal, and Rumford medals, for 1864, have been awarded as follows:—*Copley Medal*—Mr. Charles Darwin, F.R.S., for his important researches in geology, zoology, and botanical physiology. *Royal Medals*—Mr. Jacob Lockhart Clarke, F.R.S., for his researches on the intimate structure of the spinal cord and brain, and on the development of the spinal cord; Mr. Warren De La Rue, F.R.S., for his observations on the total eclipse of the sun in 1860, and for his improvements in astronomical photography. *Rumford Medal*—Dr. John Tyndall, F.R.S., for his researches on the absorption and radiation of heat by gases and vapours.

UNIFORMITY OF WEIGHTS AND MEASURES.

Dr. Farr has read to the British Association the Report of the Committee on the Uniformity of Weights and Measures. Dr. Farr then laid on the table the meter—a brass rod, which was the proposed standard of measure. It was thought to be a very mysterious thing; but, as they would observe, it looked very much like an English yard, but rather better measure.

Mr. Heywood, before reading the report, stated that the meter was 3 ft. $3\frac{3}{8}$ in. long, and derived its name from the Greek word, *μέτρον*, a measure. The association strongly recommend the adoption of the metric system, and offer to exert their influence in obtaining from Paris an authorized set of metric weights and measures, to be placed in some public and frequented building in London. Sir John Bowring spoke in favour of the system.

Professor Williamson, on behalf of the Chemical Section, bore testimony to the experience of chemists in their use of the metrical system. Mr. Ewart congratulated the section on their unanimity; and Captain Maury referred to the Confederate Government having appointed a commission on the subject.

The President observed that they had among them one of the greatest writers on practical arithmetic in the world—the Lord Bishop of Natal.

The Bishop of Natal, who was well received, declared his full assent to the report of the association in favour of the metric system, adding that the influence of the Association should be used with the Government to induce them to require that in all schools assisted by the State, the metrical system shall be regularly taught. Elementary books adapted to the new system would, of course, be prepared when the impetus is given by making such teaching compulsory in schools receiving State support.

Mr. Tite, M.P., said that, as an architect, he had had a great deal to do in France, and he found the adoption of the metric system of the greatest use in facilitating his operations, both in matters of minute measurement and account.

It is to be remembered that Mr. Ewart's bill to legalize, permissively, the use of the metric, or decimal, system of weights and measures, with the French *mètre*, *litre*, and *gramme*, for its respective standards, has become the law of the land. We may want to refer to a handbook containing a set of tables prepared to facilitate the ready conversion of all amounts reckoned by the British-Imperial standards into those which are recognised by the French and most other Continental nations. Such a volume is that published by Messrs. Lockwood and Co., which has been compiled by Mr. C. H. Dowling, civil engineer, an indefatigable labourer for the reform of the existing system. He has been assisted by Professor Airy, the Astronomer Royal, and by Mr. James Yates, Vice-President of the International Decimal Association, in verifying the fundamental numbers upon which these tables have been calculated. They are arranged so as to present both the conversion of metric into British, and of British into metric amounts, in the several categories of length, superfices, solidity, capacity, and weight. A brief historical sketch of the successive alterations in our laws and customs upon this matter is prefixed to the series of tables.—*Illustrated London News.*

THE TIDAL WAVE.

The influence of the Tidal Wave is the subject of a paper by Mr. James Croll, in the *Philosophical Magazine*. He states that Mayer has shown that the tidal wave tends to diminish the earth's rotation. This rotation carries the wave a little to the east of the meridian over which the moon is raising it, and as the attraction of the moon tends continually to pull the wave back to the meridian against the direction of rotation, the wave must act as a drag upon the earth's motion; and, as the drag acts by friction, the *vis viva* of rotation is converted into heat. Mr. Croll sets forth another way in which he thinks the tidal wave tends to diminish the earth's rotation, hitherto not noticed, which he attributes to the action of the centrifugal and centripetal forces. For the details of his explanation, accompanied by a diagram, we must refer our readers to his process of reasoning by which he arrives at his conclusion, that the tidal wave not only tends to diminish the rapidity of the rotation of the earth, but also to accelerate the mean motion of the moon.

AN AMERICAN CALCULATING MACHINE.

We have received, says the *Scientific American*, the Report for 1863, of G. W. Hough, the astronomer in charge of the Dudley Observatory at Albany. From his description of the Calculating

Machine in use at the Observatory, we make some extracts which may enable some of our readers to gain an idea of the principle of the machine:—

It is a well-known fact that Mr. Charles E. Babbage was the first to attempt the construction of a difference engine, but owing to some misunderstanding between the inventor and the English Government, under whose patronage the work was carried on, it was never completed.

About the year 1834 or 1836, Mr. Scheutz, a printer at Stockholm, heard of Mr. Babbage's machine, and at once conceived the idea of building one himself.

The present machine, which bears the impression "Stockholm, 1853," is the product of his labours, continued with unwearied diligence and at great pecuniary sacrifice, through nearly twenty years. It is the only one ever perfected, and, although based on the same mathematical theory, is yet essentially different in its mechanism from that contemplated by Mr. Babbage. It was purchased for this Observatory in 1856, and was put in operation for a short time in 1858.

Suppose it is desired to tabulate the series of square numbers beginning with unity. Let us first see how these numbers can be produced by means of successive differences. We arrange them for convenience in the following table:—

Number.	Square.	1st diff.	2nd diff.	3rd diff.
1	1			
		3		
2	4		2	
		5		0
3	9		2	
		7		
4	16			

Now suppose we have three wheels, placed one above the other on a vertical (shaft) axis, on each of which is inscribed zero and the nine digits, corresponding with a like number of divisions on their surfaces. If the number 1 on the upper wheel, 3 on the second wheel, and 2 on the third wheel, be brought opposite a fixed or zero point; and the nature of these wheels be such that when set in motion by a lever from right to left, the second wheel adds its number to the upper wheel, and by a motion of the lever from left to right, the third wheel adds its number to the second (being in this case constant and always equal to 2); from this arrangement we shall be able to compute a table of square numbers.

We begin by moving the lever from right to left; when 3 (the number on the second wheel) will be added to 1 (the number on the upper wheel), making 4, the square of 2. On moving the lever back, 2 on the third wheel is added to 3 on the second wheel, making 5. Moving our lever back again from right to left, 5 is added to 4 on the upper wheel, making 9, the square of 3. Repeat-

ing the process, we next get 7 on the second wheel, which, added to 9 on the upper, makes 16, the square of 4.

Having given the fundamental principles on which the machine is constructed, we will add a few particulars. This machine can be used to 15 places of figures, of which 8 places are printed, at the time of making the computation. Thirty seconds is the time necessary for a complete result.

Before starting the machine for any computation, it is necessary to set the proper wheels, after which, it needs no further attention; for so long as the last order of differences is constant, it will continue to produce the required numbers. Thus, for producing a table of squares, it is only necessary to give the machine three numbers, 1, 3, and 2; and from these data we can compute the squares of all numbers up to 30 millions. In the same manner, by giving the machine the numbers, 1, 7, 6, 6, we can produce a table of cubes, the limit being 15 figures. The same principles apply in the computation of logarithms, or any series of numbers whatever.

It is proposed to apply motive power to the machine, so that when once set it shall be a complete automaton, making its computations without the assistance of any person. As soon as one set of constants are exhausted, the machine will stop, and will also be made to give notice of the fact by ringing a bell; upon which a new set of constants may be introduced, and the computations continued.—*Quoted in the Mechanics' Magazine.*

THE HUMAN VOICE AND THE PITCH OF THE TUNING-FORK.

In 1860, after much discussion, at a meeting of the Society of Arts, it was agreed to raise the pitch, and that the middle C should consist of 528 vibrations instead of 512. In the *Philosophical Magazine* for November, 1864, is a paper by Mr. John Bishop, F.R.S., strongly recommending a recurrence to the old pitch, stating that his remarks have not been written as a mere theory, but in consequence of the numerous cases of injury to the human organs of voice, due to the change, which have been submitted to his opinion. In the progress of time the pitch of the songs of Handel, Mozart, and others have been gradually raised above that designed by those composers; and both the music and singers suffer by the alteration. Mr. Bishop states that even Mdme. Goldschmidt complains of the strain which the change of pitch has produced on her vocal organs. Further, it is well known that the tones at the extreme limits of phonation are never so pure in quality or so pleasant to listen to as the notes within these limits. Transposition remedies the evil for single songs; but, as Mr. Bishop remarks, no one would think of changing the key for a whole oratorio or mass. The evil is maintained by pianoforte-makers and tuners, who, of course, must make their instrument correspond to the popular standard. It is satisfactory to learn that Sir John Herschel protested against the decision of the committee of the Society of Arts; and all

parties appear to have considered the decision at which they arrived as only a temporary measure. Its complete failure to produce uniformity is undoubtedly a confirmation of his views, and shows the necessity for further investigation.—*Illustrated London News.*

PHYSIOLOGY OF THE VOICE.

Dr. Edward Fournié has read to the French Academy of Sciences a paper on this subject. By the aid of reeds, formed either of India-rubber or from the human larynx, and aided by examinations by means of the laryngoscope, he endeavours to demonstrate—1, That the glottis is a membranous reed, acting according to principles hitherto little understood; 2, That the production of the tones of the voice is the result of a combined action of longitudinal and lateral tensions, and of a diminution or enlargement of the vibrating part of the reed; 3, That the chest voice is characterised by the excitation of the whole length of the vocal cords; 4, That in the mixed voice the vocal cords are slightly separated before and behind, and that the mucus which covers them vibrates in this interval (here the lateral tension is weaker than the longitudinal and the vocal cords are more slender); and 5, That the falsetto voice is produced by a very small reed, which occupies the anterior third of the vocal cords, the tones being produced by the variation of the extent of the reed and by the longitudinal tension. M. Fournié supported his views by exhibiting an artificial larynx so constructed that he could produce all the notes that he desired with great facility.

VELOCITY OF SOUND.

Dr. Stevelly, in a paper read by him to the British Association, says: "Suppose a piece of clockwork prepared, for instance, to strike single strokes upon a bell each time the detent is set free; the detent to be under the control of an electro-magnet, which is instantly set in action by an observer, at a measured distance from the bell or other origin of sound, depressing a key, and thus completing a galvanic circuit. The observer, being furnished with a chronometer, depresses the key; the instant he hears the stroke of the bell he again depresses it; hears a second sound, and so goes on for 100 or 1000 times, carefully noting by the chronometer the instant at which he hears the last sound of the series. A trained observer would not make a probable error of one-tenth of a second in noting the whole time occupied by the whole series; and to avoid all chance of miscounting the number of sounds in the series, the clock may be readily made to keep count of the number of strokes it makes. The whole time occupied by the entire series is made up of the following portions: 1st. The time consumed in the mechanical work of the clock in producing the stroke, and of the key, from the instant the observer touches it until it has completed the circuit. 2nd. The personal

equation of the observer. 3rd. The time the sound takes to travel 100 (or 1000) times the measured distance of the origin of the sound from the observer. 4th. The time the sound takes to travel 100 (or 1000 times, as the case may be), the measured distance. Now, the first, second, and fourth of these portions of time can be readily eliminated by repeating the same series of observations exactly (the clock being wound up at the commencement of each series exactly to the same extent); the observer, on the second occasion placing himself at one-half, or one-fourth, or at any determined part of his previous distance from the origin of sound; or by placing himself close up to it, using the same wires for the galvanic circuit on each occasion, in order to eliminate the fourth portion. The author was not fully aware of the exact mechanism by which Prof. Piazzi Smyth discharges the cannons which he has introduced as time signals, but he had no doubt it could be adapted to this method, and thus determine experimentally whether the velocity of sound is affected by the violence of its originating cause: a question which Mr. Earnshaw has from theory decided in the affirmative. It would, however, involve, the author supposed, the use of two cannons, each alternately to be in process of being charged while the other was at work. This, however, either at Greenwich or Edinburgh could be readily accomplished.

As an illustration of the distance to which Sound travels, Mr. G. S. Poole, of Brent-knoll, Weston-super-Mare, writes that he distinctly heard the firing of the guns of the *Alabama* and *Kearsage*. Thinking it highly improbable that the local artillery of Weston-super-Mare would be practising on that day, and finding no other way to account for the noise, he conjectured that it was a fight between two Federal and Confederate ships, and events proved that he was right. His house is situated on an elevation about 110 ft. above the level of the surrounding district, and thus it seems the noise of the conflict travelled the enormous distance of about 115 miles.

NOTICE OF THE PHYSICAL ASPECT OF THE SUN, BY PROF. PHILLIPS.

SINCE the author had been provided with the diagonal sun-glass adjusted to his equatorial by Mr. Cooke, he had taken many occasions of scrutinizing the aspect of the sun's disc in regard to spots, faculæ, and the general porosity of the surface. For tracing the path of a spot across the disc, a Killner eye-piece was employed, with five engraved transit lines, the intervals been equal to 10 deg. in the central part of the sun's circumference. In drawing, negative eye-pieces of the ordinary kind were sometimes employed; at others, a peculiar kind, arranged by himself, with powers varying from 75 to 300; the best performances being usually between 100 and 200; the higher powers, however, being occasionally useful towards the limb of the sun. He describes the bright streaks

or faculæ as of diversified form and distinct outline, either entirely separate or coalescing in various ways into ridges and network. When the spots became invisible near the limb, the undulated shining ridges and folds still indicated their place, being more remarkable thereabout than elsewhere on the limb, though almost everywhere traceable in good observing weather. In a diagram made on the 29th of March, 1864, faculæ are shown in the most brilliant parts of the sun. They appear of all magnitudes, from barely discernible, softly-gleaming spots 1000 miles long, to continuous, complicated, and heaped ridges 40,000 and more miles in length, and 1000 to 4000 miles and more broad. They are never regularly arched, and never found in straight bands, but always devious and minutely undulated, like clouds in the evening sky or very distant ranges of snowy mountains. When minutely studied, the ridges appear prominent in cusps and depressed into hollows. By the frequent meeting of the bright ridges, spaces of the sun's surface are included of various magnitudes, and forms somewhat corresponding to the areas and forms of the irregular spots with penumbræ. Ridges of this kind often embrace and inclose a spot, though not very closely, the spot appearing the more conspicuous from the surrounding brightness; but sometimes there appears a broad white platform round the spot, and from this the white crumpled ridges pass in various directions. Towards the limb the ridges appear nearly parallel to it; further off this character is exchanged for indeterminate direction and lessened distinctness; over the rest of the surface they are less conspicuous, but can be traced as an irregular network, more or less designated by that structure which has been designated as porosity. The faculæ preserve their shapes and position, with no visible change during a few hours of observation, and probably for much longer periods. They do not appear to project beyond the general circular outline of the sun, a circumstance which the author explains, without denying that they actually do rise above the general surface, whether as clouds or mountains, to either of which they may be truly likened. In respect to porosity, the author had also devoted much time to a scrutiny of the interspaces between the faculæ towards the limb and the general surface towards the interior of the disc. Towards the interior the ground acquires more evident lights and shades, a sort of granulation difficult to analyse. Under favourable conditions for observation, there appears little or none of that tremor and internal motion described by earlier observers. What is then seen is a complicated surface of interrupted lights, and the limits of which appear arched, or straight, or confused, according to the case; and the indeterminate union of these produces sometimes faint luminous ridges, the intervals filled up by shaded interstices and insulated patches of illuminated surface. The best resemblance to these complicated small surfaces of light and shade he had been able to procure was a disc of a particular sort of white paper placed near the eye-end of the telescope, and seen by transmitted light. Heaps of small fragments of white

substances, not so uniform in figure or equal in size as rice-grains, might also be suggested for comparison.—*Proceedings of the British Association.*

THE SOLAR SYSTEM.

THE doctrine of the Stability of the Solar System is considered by modern astronomers to be a fact established on the most satisfactory evidence. It is, however assailed by Professor Gustav Heinrichs, in an elaborate paper inserted in the American *Journal of Science*, No. 109. He considers, in the first place, the effects of resistance, referring to the evidence of it in the case of Encke's comet; and from his calculations deduces the following four laws:—1. That with advancing age the nearest secondary planet approaches its primary; 2. The entire system of orbits becomes closer; 3. The regularity and symmetry disappear more and more; and 4. That at corresponding ages similar systems must represent the same configuration. He next examines at some length the laws of density and rotation, giving the result in fifteen conclusions. We give the two last:—14. If the laws of attraction are not fully identical with those of repulsion, the created matter would already virtually contain the tangential force upon which the duration of the whole world principally depends. This is simply an instance of "throwing the first cause further back," since the translatory movement no longer needs to be considered as a direct action of the Creator, but as a design embodied and effected through some previous direct act. 15. It is probable that the force lost in resistance is converted into magnetism. "I know that some, like Brewster, will object to these and similar efforts; yet we always feel the more deeply convinced of the glory, and power, and wisdom of the Creator and Governor of the universe the more we perceive how simple His means, how grand His design, and how multiform His efforts. Unlike ourselves, the Creator needs no tools, no constant effort for producing His ends. His Almighty 'fiat' created the universe, and His right hand sustains it ever since."

THEORY OF THE CONSTITUTION OF THE SUN.

THE following is a *résumé* of a long memoir on this subject, by M. Emile Gautier, in the *Bibliothèque Universelle*, in which he gives an account of the principal observations and theories that have been hitherto published. 1. The sun is a liquid incandescent globe, composed of elements similar to those which enter into the composition of the earth, and probably into that of the planetary system. It exists in a state analogous to the phase of liquidity through which the earth has passed, according to the opinion generally entertained by geologists. The high temperature by which its liquidity is maintained considerably dilates its volume, and explains the feeble relative density of the globe in a state of fusion. 2. An atmosphere envelopes the liquid mass, and incloses

in suspension vapours or emanations of all kinds; so that its lower strata ought to be comparatively heavier than those of the terrestrial atmosphere. As the rotatory motion of the central globe cannot be supposed to be transmitted to its gaseous envelope so far as its most elevated limits with the same angular velocity, the solar atmosphere is probably susceptible of exercising on the liquid surface an action analogous to that of friction. 3. The emanations or metallic vapours surrounding the sun, and impregnated with dust, smoke, or lava, form around it a layer of variable thickness, and present total eclipses, the appearances of red borders, and protuberances. 4. The solar dark spots are partial solidifications of the surface, due either to cooling or to chemical action, re-uniting momentarily into aggregates, salts, or oxides, which have issued from the mass in fusion and float on its surface. 5. The faculæ (bright spots) are the result of the appearance on the sun of very brilliant substances, endowed with great radiating power. 6. The acceleration observed in the rotatory movement of the spots situated near the solar equator is the result of the exterior action of the atmospheric pressure on the liquid surface, combined with that of the interior layers of the mass in fusion. Accidental irregularities may proceed from the disturbance of the chemical and physical equilibrium of the various materials composing the mass.—*Illustrated London News.*

THE SUN'S ATMOSPHERE.

FROM the second part of Kirchhoff's *Researches on the Solar Spectrum and the Spectra of the Chemical Elements* (a translation of which, by Professor Roscoe, has appeared), we learn that the evidence of the existence of potassium in the solar atmosphere has broken down under closer examination; but that additional evidence has been obtained of the existence therein of iron, nickel, barium, copper, zinc, strontium, cadmium, &c.; and that no additional elements have been found in the sun. We regret to learn that Professor Kirchhoff's eyesight has been so materially weakened by his constant application to the spectroscope that he has been compelled to commit the practical observation to his pupil, Mr. G. Hofmann.

SOLAR RADIATION.

THE intensity of the Solar Radiation at different seasons of the year has been investigated by Father Secchi, of the Observatory at Rome. We give some of the results from his paper, printed in No. 1 of vol. 58 of the *Comptes Rendus* of the French Academy of Sciences, before whom it has been read. We have not space for the description of the apparatus employed, and with which he made a great number of observations during the summer, repeating them during the perfectly clear days between Nov. 22 and Dec. 8 last, when he exposed the apparatus to the solar radiation under

the dome of the observatory until the temperature remained perfectly constant for a considerable time. 1. During summer, near the meridian and near the solstice, the relative temperature varied from 14 deg. to 11 deg. Cent., the mean being 12·06 deg. 2. The observations continued during August gave 13 deg. to 11 deg.; the mean, 12 deg. 3. Those made in November and December gave 12·5 deg., 11·5 deg., the mean not being sensibly changed. 4. When observing in summer, near the horizon, at an elevation of 30 deg. to 34 deg., he found the temperature rose only to 6·5 deg. 5. The rapidity with which the blackened thermometer rose was scarcely different in summer from winter until 10 deg. or 11 deg.; but after this limit the maximum was attained sooner in summer than in winter. The results obtained in the latter season were completely unexpected. Father Secchi thought that observing the sun at a height of about 28 deg. he would find a temperature quite, or nearly, equal to that which he had found in summer at 32 deg. of elevation, the atmospheric density being nearly the same; but it was not so. At the meridian he found nearly the same amount as in summer, although the rays traversed a thickness of atmosphere more than double, while this double thickness diminished the force of the radiation, reducing it to the half. These phenomena would be inexplicable if we did not know the absorbing power of the aqueous vapour. Father Secchi expresses his agreement with the results obtained by Professor Tyndall, estimating its absorbing power at sixty times that of air. —*Illustrated London News*.

THE ENVELOPES OF THE SUN AND HIS SPOTS

Have been the subject of a paper by Mr. Dawes, read at a meeting of the Royal Astronomical Society. The mottled surface of the sun can be seen with a low power. It has been variously described, and appeared to Mr. Dawes in many ways; but he stated that he had not been able to verify the appearance of the "willow leaves" described by Mr. Nasmyth. Mr. Dawes considers Sir John Herschel's words, "the surface is like some flocculent chemical precipitate slowly settling down," to be by far the best description of the solar disc. When Mr. Dawes used a very small perforation, with an eyepiece of high powers (400 to 600) he rarely saw much change in the pores, except in the vicinity of the spots, which were rapidly expanding or closing, when the appearance of the surface at the margin resembled small bits of straw or thatching, interlacing in all directions. He says, that with regard to the spots in the black centres, distinction ought to be made between the umbra and the nucleus. The existence or absence of this black central portion may possibly determine the origin of the spots. An account of the interesting discussion which followed the reading of this paper will be found in the *Astronomical Register* for January.

TELESCOPIC APPEARANCE OF THE PHOTOSPHERE OF THE SUN.

A DISCUSSION has arisen among astronomers whether the general appearance of the Solar Photosphere is that of a flocculent precipitate, as suggested by Sir John Herschel and assented to by Mr. Dawes, or whether it more nearly resembles a willow-leaved crystalline precipitate of detached particles (the smallest of them having an area exceeding that of the British Isles), as originally described by Mr. Nasmyth and confirmed by Mr. De la Rue. We read in a note in the *Notices of the Astronomical Society* that to Mr. Stone, observing these "particles" with the large Greenwich refractor, the sun's photosphere appeared as if covered with grains of rice, "solid bodies, somewhat uniform in size and shape, the immediate origin of the solar light!"

ELECTRICITY FROM THE SUN'S RAYS.

MR. H. KEVIL has read to the British Association a paper on the development of Electricity from the Rays of the Sun and other Sources of Light, which he illustrated by the exhibition of indicators or needles suspended within two exhausted glass receivers, and which he showed were operated upon by the action of rays of light.

A Member inquired how the author knew that the motion resulted not from electricity, but air remaining in the receiver?—Mr. Keevil replied that he merely gave his own impression. The air had been exhausted by the pump in the usual way.

Mr. F. Jenkin remarked that those who had been in the habit of making experiments with magnetic needles knew how difficult it was to keep them quite free from disturbance of the air. His own impression was that the motion of the indicators in the receivers in the present case was due to what Dr. Tyndall called "small tempests." They must have all found from their own experiments that it was impossible to get absolute rest; and if they allowed fire or anything else to act upon the receiver, no doubt the words of Dr. Tyndall, as to the "little tempests," would apply.

The President of the Section had no doubt that electricity would affect the needle; the only question was, to what extent.

Dr. Goodman added, that in experiments he had made it had been observed that the effect was always about equal to ten degrees in one state of the sun, and only two in another, thus showing that the action was the result of some existing law.

LUNAR OBSERVATIONS.

THE Rev. T. Webb has read to the British Association a paper on the invisible part of the Moon's surface. Quoting M. Hansen's view, that the centre of gravity did not coincide with the centre of the figure of the lunar globe, and the results he drew of the possibility that the visible hemisphere of the

moon, in reference to its whole volume, was one gigantic mountain or high range, in relation to which the other side would present a region of comparative depression, consisting of air, earth, and water, and peopled with a race of beings something like ourselves—Mr. Webb said there was considerable interest in the arguments that might be advanced on either side of this hypothesis. These the author proceeded to canvass, without offering any positive opinion of his own; observing, however, that there was nothing to contravene the idea that there existed an atmosphere at the back of the moon, compatible with the requirements of vegetable, and even animal life; but calling attention to the fact that the observations of the visible hemisphere seemed to lead to the conclusion that the volcanic character of the moon was not favourable to the supposition that the moon was inhabited.

The President of the Section remarked that the theory of M. Hansen was purely a mathematical one, and it was only right to say, that Professor Adams entirely disagreed from M. Hansen's conclusions.

A Member of the Committee spoke in confirmation of this statement, and a brief discussion ensued as to the basis upon which M. Hansen had advanced his theory, and especially upon the question whether the moon had any atmosphere or not.

DAY AND NIGHT IN THE MOON.

Mr. James Nasmyth, in his discourse to the Royal Institution upon this inquiry, began by referring to the favourable situation of the Moon, and the frequent times we have for observing its various phases. In regard to the great evidence of volcanic action in the formation of the moon's surface, he expressed his own conviction that all volcanic action is of cosmical origin, and as ancient as the planets themselves; the heat being essentially different to that of ordinary combustion, which required the presence of oxygen. The moon, like the earth, he believed to have been originally formed of nebulous material, beginning with a nucleus round which the material formed; this, by contracting, generated enormous heat, and rise to the volcanic phenomena. The small mass of the moon, in proportion to its surface, he attributed to rapid cooling; and he referred to the interesting evidence of there having been on the surface at one time a molten tide; and also expressed his strong conviction of the vast antiquity of the moon's surface, geologically speaking. He then set forth the evidence which showed that the moon had no atmosphere, no water or clouds, and no winds; and showed no marks of disintegrating or denuding action such as the earth had undergone, and to which the latter owed the variety of soils so essential to vegetation. He then, by aid of very characteristic drawings, pointed out the most striking physical features of the moon's surface, such as ring-shaped mountains and craters, central cones, landslips, mountains of exudation, cracks filled up, bright streaks, and wrinkles; and illustrated the phenomena of the cracks by glass globes heated by a lamp and then contracted. A "day in the moon" equals fourteen of our days. It begins with a slow sunrise, followed by brilliant sunshine and intense heat (above 212 deg. Fahr.) The sky is intensely black (there being no atmosphere like ours, to which blue sky is due); the stars are visible, and the horizon is limited; there is dead silence; the cold in the intensely black shadow is very great; and there is no aerial perspective. Thus the moon is no place for man, or any animals, or vegetables that we know of. The "night in the moon" (fourteen of our days) begins with a slow sunset, which is followed by intense cold (about 334 deg. below zero). In addition to the use of the moon as a source of light, Mr. Nasmyth especially dwelt on its sanitary action during the tides, and added that, by tides, the moon actually gave us light and heat, by bringing up coals to London. An image of Mr. Warren De la Rue's beautiful photograph of the moon was thrown on the screen by means of the electric lamp.

EXTENSIVE LUNAR PLAIN.

Dr. Lee has described to the British Association "An Extensive Lunar Plain near the Montes Hercynii, which it is proposed to name Otto Struve." The large plain in the north-east quadrant of the Moon, formerly designated by the Hanoverian astronomer Schröter "Lichtenberg," is situated between two mountain chains, to the easternmost of which the German selenographers, Beer and Mädler, appropriated the term "Montes Hercynii," at the same time transferring the name "Lichtenberg" to a crater some little distance from this plain. Dr. Lee illustrated his description of the plain and its surrounding mountains by copies of the four delineations of the plain, at present all that are in existence: one by Schröter, made in the year 1792; the portion of Beer and Mädler's map of this region; a fine drawing of the northern part of the plain by Lord Rosse; and an unpublished drawing by Mr. Birt, executed during the present year. In these drawings, Dr. Lee pointed out the features that were common to them, especially a large crater on the north part of the west wall, which was very conspicuous in them all. There were also craters quite conspicuous in Schröter's, Lord Rosse's, and Mr. Birt's drawings, which were not apparent in Beer's and Mädler's. After alluding to the confusion likely to arise from the changes in the names before mentioned, Dr. Lee suggested that in future this large plain should be denominated "Otto Struve," as commemorative of the extensive astronomical labours of the astronomer of Pulkova.

ENLARGED PHOTOGRAPH OF THE MOON.

MR. BROTHERS, of Manchester, has exhibited to the British Association a photograph which had been made from a negative by Warren De La Rue, F.R.S. The original negative is one inch in diameter, and from this a positive two inches in diameter was first made. This was placed within the rays of a nine inch condenser of the solar camera, and an enlarged negative on a plate 36 in. by 24 in. was produced. The print exhibited was on a single sheet of paper; and thus the disadvantage of joining several sheets together, as in other large prints of the moon, was avoided. Various effects from the same negative could be produced by providing either for the finer details of the strongly illuminated side of the moon, or for the more rugged parts at the side near and at the terminator. The sharpness of the photographs was very marked, and their effect was very striking and satisfactory.

LUMINOUS METEORS.

MR. GLAISHER has read to the British Association a Report on Luminous Meteors of the past year. The Committee have the satisfaction to point out numerous observations of fireballs (or the largest class of meteors) contributed for the Catalogue by members, and other friends of the Association. The largest fireball described in the catalogue was seen on the night of the 5th December, 1863, which produced the vivid impression of lightning over the whole of the British Isles. Fireballs described in Paris are greatly underrated: for meteors of the largest class are there rated only six times brighter than Venus. Full-moon light is, on the contrary, at least 1300 times greater than the light of Venus. Two small fireballs were seen in a short space of time on the 21st of January, and two again of the largest size on the 4th of July, 1864. Two fireballs closely followed the observation of a large meteor at Athens by Dr. Schmidt on the 19th of October, 1863, one in England, and the second on the coast of Spain. Like the fireball of 1783, the meteor was composed of large and smaller globes irresistibly recalling the showers of stones at L'Aigle, and at Stannem, as illustrating the native principles of their architecture. The mechanical theory of the heat, roughly estimated from the light of twenty shooting-stars doubly observed in August, 1863, proved the average weight of these to have been little more than two ounces avoirdupois. A similar estimate of the largest fireball of the present catalogue (December 5th, 1863), would furnish nearly a hundredweight of material substance. Dr. Haidinger supposes that non-productive fireballs and shooting-stars are loosely compacted in their substance, and thus accounts for their want of penetrating power. Professor Newton and Dr. Herschel conclude, independently, that shooting-stars commence at 70 miles, and disappear at 50 miles above the surface of the earth. At 60 miles above the earth shooting-stars are far more frequent than at any

other altitude, and they are considerably more common between 40 and 80 miles above the earth than in all other elevations put together. The region from 40 to 80 miles above the earth is the "stable atmosphere" of M. Guetelet, as determined by the heights of shooting-stars. It cannot, on the received law of decrease of density, comprise more than 1-10,000th part by weight of the total shell of the atmosphere. Yet the 9999 parts of the remaining atmosphere below are very seldom molested by the presence of shooting-stars. It appears necessary on this account to retrench very greatly the weights of unproductive fireballs and shooting-stars.

The observations of meteors on the 9th and 10th of August, 1864, indicate a display ranking very nearly with the general average of the phenomenon; which, in the clear sky, and the absence of the moon, amounts to between 30 and 40 meteors per hour for a single observer constantly regarding the sky near the zenith. In numbers the phenomenon was not a half, and in brilliancy not a small fraction, of the display of the preceding year. It was less striking on the 10th than on the 9th of August, consistently with the ordinary conditions of leap-year. If any indication of periodicity can yet be traced in the fluctuations of this phenomenon, it is perhaps a minimum at intervals of eight years, which has thrice occurred, and last in 1862.

MICROSCOPICAL STRUCTURE OF METEORITES.

MR. H. C. SORBY, in his paper in the Proceedings of the Royal Society, says that, in the first place, it is important to remark that the olivine of Meteorites contains most excellent "glass cavities," similar to those in the olivine of lavas, thus proving that the material was at one time in a state of igneous fusion. The olivine also contains "gas cavities," like those so common in volcanic minerals, thus indicating the presence of some gas or vapour. To see these cavities distinctly, a carefully-prepared thin section and a magnifying power of several hundreds are required. The vitreous substance found in the cavities is also to be met with outside and amongst the crystals, in such a manner as to show that it is the uncrystalline residue of the material in which they were formed. It is of a claret or brownish colour, and possesses the characteristic structure and optical properties of artificial glasses. Some isolated portions of meteorites have also a structure very similar to that of stony lavas, where the shape and mutual relations of the crystals to each other proved that they were formed in situ on solidification. A structure is also found so remarkably like that of consolidated volcanic ashes as to be mistaken for it. It would appear that after the material of the meteorites was melted a considerable portion was broken up into small fragments, subsequently collected together, and more or less consolidated by mechanical and chemical means, amongst which must be classed a segregation of iron, either in the metallic state or in combination with other substances.

"There are," says Mr. Sorby, "certain peculiarities in physical structure which connect meteorites with volcanic rocks, and, at the same time, others in which they differ most characteristically—facts which, I think, must be borne in mind not only in forming a conclusion as to the origin of meteorites, but also in attempting to explain volcanic action in general."

STONES FALLEN FROM THE ATMOSPHERE.

Dr. Phipson has described to the British Association the Black Stones which Fell from the Atmosphere at Birmingham in great quantities during a violent storm which broke over the town in the month of August, 1864. They were small, angular, and black, presenting here and there a few indications of crystallization. They acted very slightly on a magnetic needle; they gave a lightish-coloured streak, and when finely pulverized were partially soluble in hydrochloric acid. The analysis which he had made of them proved that the stones were not aerolites, but small fragments of basaltic rock, similar to that which existed a few leagues from Birmingham, near the parish of Rowley. Dr. Phipson believed that the stones had been carried to Birmingham by a waterspout.

VISIBILITY OF COMETS AND NEBULOUS MATTER.

That Nebulous Matter, or Cosmical Vapour, if it exists in the heavens, should be visible by a suitable optical aid, is a prevailing opinion. Mr. D. Trowbridge, in the *American Journal of Science*, adduces reasons to show that this notion is erroneous except in some cases. He says that comets are the only celestial objects, whose physical constitution is approximately understood, that afford us anything like a distinct notion of what nebulous matter is. By far the greater proportion of these bodies are composed of materials so extremely rare that solar rays can penetrate completely through the denser portion of their bodies, and the light in some cases seems to suffer scarcely any diminution in intensity. Yet these bodies, which, perhaps, would weigh at the surface of the earth but a few ounces, or but a few pounds, are distinctly visible with the smallest optical aid, and even, under favourable circumstances, with the naked eye. Sir John Herschel says, of this class of comets, that the most unsubstantial clouds which float in the higher regions of our atmosphere must be looked upon as dense and massive bodies, in comparison with the almost spiritual texture of these light bodies. A cloud composed of materials so rare, and whose distance from us did not exceed fifteen or twenty miles, would scarcely be visible. A comet, however, will be visible when its distance from us is many millions of miles. These facts, Mr. Trowbridge thinks, clearly indicate that comets do not shine wholly by reflected light. Arago, on July 3, 1819, tried to analyse the light of a comet by his polariscope, and found that it gave unmistakable signs of polarised light, and therefore of reflected sunlight. Humboldt, in his "Cosmos," conjectures that comets and planets may have an independent light of their own. Mr. Hind thinks that reflected solar light cannot completely account for all the phenomena of the light of comets. Their visibility in the day-time, and when near the sun, also indicates a light-generating process, and their heads contract in dimension as they approach that luminary. Perhaps the chemical action of the solar rays upon comets causes them to send out more direct light. Mr. Trowbridge also conjectures that the influence of the magnetic power of the sun may be a potent cause to render comets visible as they approach the great central luminary, and refers to the connection between auroræ and the solar spots and atmospheric magnetism. With regard to nebulæ proper, he concludes that nebulous vapour is necessarily too diffuse to be visible when far removed from us; condensation and conversion into stars alone can render nebulæ visible to us. Higher telescopic power resolves nebulæ; and it is doubtful whether our best telescopes may ever bring into view any real nebulæ.

THE RELATIVE HEATING OF THE SOIL AND AIR

By the solar rays on a high mountain and in a plain, has been examined by the distinguished traveller, M. Ch. Martens, who has reported on the subject to the Academy of Sciences at Paris. We give a few notes:—A solar ray, it is said, falling on an elevated summit, should be hotter than one which, after traversing the lower and denser strata of the atmosphere, descends into the plain, since these strata necessarily absorb a notable quantity of the heat of the ray. All travellers who have ascended high mountains have been surprised at the extraordinary heat of the sun and the soil compared with the temperature of the air in the shade or with that of the soil during the night. The observations of MM. Peltier, Bravaris, and Martens (two series, 125 in the whole) made on the Fauthorn, Switzerland, between 6 a.m. and 6 p.m. continued indifferently in fine and bad weather, give, nevertheless, for the mean temperature of the soil during the day, 11·75 cent., that of the air being only 5·50. It became evident that heating of the soil during the day was twice that of the air; but the observers were not aware what had been the relative heating of the earth and air in the plain below during the same period. To obtain this knowledge, M. Martens selected the summit of the Pic du Midi, in the Pyrenees, and a garden in the plain at Bagnières. By his observations, which began on Sept. 8, 1864, he obtained the following results:—The mean of the temperature of the air in the shade, deduced from twenty observations at Bagnières, was 22·3; from the same on the Pic du Midi 10·1 only. The mean temperature of the surface of the soil at Bagnières was 36·1; on the Pic, 33·8. The mean excess of the temperature of the soil over that of the air at the two stations is then as 10 : 171:—nearly double that on the mountain. These experiments put out of doubt

the greater calorific power of the sun upon the mountain than upon the plain. For the method of observation employed by this distinguished meteorologist, and the additional results obtained, we must refer our readers to the *Comptes Rendus* of the Academy, Vol. lix. No. 16.—*Illustrated London News.*

ON SNOW.

The limit of persistent Snow has been examined by several philosophers. Bouguer thought that it corresponded to a mean annual temperature equal to zero; De Buch and Humboldt endeavoured to show that it approached rather a mean temperature of summer equal to zero. M. Renou, in a memoir recently laid before the Academy of Sciences at Paris, expresses his dissent from these views, referring to Durocher's observations, who, after giving the mean temperature of the year at the equator as 1·5 cent., of the Alps 4·0, of the Polar circle, Norway, 6·0, and the mean temperature of the summer at the same places as 3, 6, 9, concludes that a number of other local and general conditions affect this limit, independently of meteorology. We have not space for the reasons which have led M. Renou to conclude that he has discovered the following law:—That in "all countries of the earth the limit of persistent snow is the altitude at which the hottest half of the year has a mean temperature equal to that of melting ice." He gives the result of observations made with regard to mountains in all parts of the world, in *Comptes Rendus*, lviii. 8.

ARTIFICIAL RAINBOW.

M. J. Duboscq has contrived for the French theatre a method of imitating the Rainbow, of which *Cosmos* speaks highly. M. Duboscq employs an electric light, obtained with the aid of 100 Bunsen elements. The first lenses of his optical apparatus render the rays from this source parallel, and transmit them through a rainbow-shaped hole in a screen to a double convex lens of very short focus, from which they pass to a prism, and emerge with sufficient divergence to make an effective rainbow on a screen about 6 yards off. This rainbow is said to be brilliant even when the whole scene is lit up.

PHENOMENA PRODUCED BY REVOLVING DISCS.

Professor Dove, some years ago, obtained a lustrous appearance by the binocular combination of geometrical figures executed in black and white or in complementary colours; and in 1861 Professor D. Rood showed that *surfaces* without drawings produced the same effect, publishing his experiments in the *American Journal of Science.* The latter *savant,* in the same journal, has just published some additional experiments, from which we select the following:—"A circular disc of white cardboard, 9 in. in diameter, with half its surface painted of a dead black, was caused to rotate by clockwork at varying rates, while the bright light from a window fell upon it. A stereoscope, from which the ground glass had been removed, was provided with a cardboard in which were cut two square apertures, at such a distance asunder that their binocular union could be easily effected, and while the disc was at rest the stereoscope was arranged so that through the right hand aperture some of the white portion of the disc was seen, and through the left-hand aperture a part of the blackened surface. On communicating rotary motion to the disc, a more or less rapid alternation of black and white was the result. It was found that with slow rates of rotation the strength of the lustre was not impaired, and it was just as plainly perceptible with more rapid rates. But when the disc was made to revolve so fast that its surface seemed covered by a uniform tint of grey, and the so-called flickering had ceased, no lustre, in the proper sense of the term, could be seen, the appearance being exactly that which is presented to a single eye under similar circumstances."

OPTICAL PROPERTIES OF THE METALS.

M. Quincke's paper on this subject, printed in the *Philosophical Magazine* for March, 1864, is devoted to the transmission of light through thin films of metal, with especial relation to the researches of Faraday, who remarked the irregularity of the intensity and colour of the light in the same metal. This, M. Quincke says, would have been attributed to the presence of holes in the plate, if Faraday had not demonstrated the property of a thin metallic film—viz., that when placed obliquely between two crossed Nicol's prisms, it illuminates the plate and acts "just like a glass plate." This property, M. Quincke thinks, was first observed by Mr. Warren De la Rue, with regard to gold leaf, and afterwards by Faraday, in thin transparent plates of platinum, palladium, rhodium, silver, copper, tin, lead, iron, zinc, and aluminium. Faraday also found that by employing polarised light and an arrangement of sulphate of lime plates, other colours than green could be transmitted by the gold leaf. The details given by M. Quincke in regard to his own experiments on this subject are too profound for our pages, and we merely give a part of his results. "Light," he says, "penetrates to an appreciable depth into the metal, and must also be reflected back from the interior; for the great difference of phase of the components of reflected light seems to be only explicable on the supposition that the reflected ray has to pass through the boundary between the metal and the medium lying adjacent to it." M. Quincke endeavoured to determine directly the velocity of light through metals, and obtained the remarkable result that light travels faster through gold and silver than through a vacuum. He says, finally, that he was unable to detect any difference of phase in the components of the light which had previously passed through transparent substances, such as plates of glass. "Therefore the analogy between metals and transparent bodies, which Jamin has proved for reflected light, is not maintained for reflected light."—*Illustrated London News.*

NEW SPECTROSCOPE.

A New form of Spectroscope, in which direct vision is obtained with a single prism, has been described to the British Association by Mr. J. Browning. Some time since it was suggested to the author by Mr. Huggins, that a direct vision spectroscope more powerful than Hoffman's would be a valuable addition to the instruments used for spectrum analysis. If made portable for travellers, it could be used in the manner of a telescope for observing differences in the solar spectrum at various elevations, for the spectra of flames, the absorption bands produced by different liquids; and, above all, it would be most readily adaptable to telescopes for examining the spectra of stars. Whilst the author was engaged on various contrivances having this end in view, Mr. A. Herschel showed him a single prism he had contrived, which answered the purpose. It was of the form that has been termed 3 to 1 right-angled, from the hypothenuse being three times as large as the base. These proportions are very simple and easy of execution. In this prism, which was of crown-glass 2·5 specific gravity, refraction occurs both in the ray of light entering at the perpendicular near the point, and also on its leaving the prism by the short face; the correction of the inclination of the ray so as to make it emerge in the same line as it enters being effected by its performing two internal reflexions. In making this kind of prism of very dense flint glass, the author had found the task more difficult than he had anticipated: all the angles required considerable modification, and it became very difficult to keep the path of the ray within the prism. The best results had been obtained by throwing the ray to the left of the prism, and correcting this by cementing a small crown-glass prism to the short face. The refractive angle, exercising a contrary dispersion, need not be more than 5°; scarcely more than a tenth of that employed by Hoffman in his construction. The three surfaces of this prism being in use, must be all equally true, or the definition suffers. After the result of all the experiments he had made, the author would wish to express his conviction that whatever advantages may be gained on the score of portability or convenience in use, they were more than counterbalanced by the inferior performance of these arrangements, when compared with plain prisms of the best workmanship. In connexion with his paper, the author added some important remarks on the great difficulty encountered in working plane surfaces on extra dense glass pri-ms, and exhibited two wonderfully delicate instruments for measuring the irregularities. With the first, inequalities of $\frac{1}{20000}$ of an inch could be taken by direct reading, and of $\frac{1}{50000}$ of an inch by estimation; with the second, inequalities of the $\frac{1}{1000000}$ of an inch were discoverable. The common method is to take the reflexion of a distant image through a telescope; but the exquisite prisms Mr. Browning has produced fully justify his choice of direct mechanical means for proving the perfection of their surface-planes.

COLOURING OF AGATES.

Some interesting details have been given to the British Association by Professor Tennant, respecting the structure of Agate and the artifices resorted to by the workmen of Oberstein in Colouring the Agate ornaments manufactured at that place and distributed over Europe. A large number of specimens were exhibited, not only of ornaments but of the stones, both cut and uncut, the former well adapted to show the structure. The black colour is produced by steeping the specimens in oil, and then blackening them by the action of sulphuric acid.

Mr. Tennant asked Mr. Tomlinson to speak on the subject, when that gentleman gave some particulars respecting the organization of the factory at Oberstein, and remarked that the principle of colourization depended on the structure of the stones: they consisted of alternate bands of crystalline and amorphous quartz, the latter only absorbing the colouring matter, which consisted mostly of oxide of iron. The workmen kept the pebbles in tubs of water containing the oxide for a longer or shorter time according to the tint required; the crystalline bands remained white, the non-crystalline absorbed the colour throughout. Professor Sullivan remarked that the structure of agate illustrated beautifully the difference between *colloids* and *crystalloids*. The alkaline silicates, by repose, formed these two classes of bodies, and he had no doubt a similar action had been at work in the formation of agate.

ORGANIC BODIES AND OPTICAL PROPERTIES.

Professor Stokes has read to the Royal Institution a discourse "On the Discrimination of Organic Bodies by their Optical Properties," especially by means of the apparatus of Kirchhoff and Bunsen, whereby the spectrum of any substance may be produced with the greatest facility—thus affording a test for the presence of certain substances in compounds, showing their chemical identity, &c. By means of the electric lamp and the large apparatus of the institution, the Professor was enabled to exhibit the results of his delicate experiments to a large audience. He referred to the relation of all substances to light, and to their different refractive and dispersive powers, as manifested in mixtures, pointing out how exceedingly available colour is in determining the chemical character of a body. He first exhibited, by way of contrast, an impure spectrum produced by the introduction of a piece of silver in the light, and then the pure, continuous spectrum of the lamp itself. He then showed the varied action of the different rays of the pure spectrum, caused by putting in the flame a peculiar salt of copper—some rays being cut off and others rendered opaque. He next took two bodies very alike in colour—diluted port wine and diluted blood—and exhibited their totally different spectra. In the spectrum of blood certain rays were cut off or obscured, while two distinct red bands were manifest—these last appeared in the

spectra of several mixtures which contained blood, and even in hæmatine, an extract from that fluid. By examining the spectrum of salts of iron it was shown that the colour of the blood is not due to the presence of that mineral; it was suggested that it is probably derived from the complex nature of its crystals. Professor Stokes stated that he had selected blood as a striking example of the way in which the chemical character of bodies may be tested by their relation to light, and concluded his lecture by some experiments showing the different colours of bodies when seen by reflected or transmitted light, and the optical phenomenon termed fluorescence (a peculiar power of producing a glow of light possessed by a solution of the sulphate of quinine, the decoction of horse-chestnut bark, uranium glass, &c.), and expressed his views in regard to the relation which these phenomena bore to the subject of his lecture.

NEW METAL, INDIUM.

THIS New Metal derives its name from certain blue lines seen in its spectrum; but it is now stated that, if a suitable Indium salt be brought into the flame of a Bunsen's lamp, the flame becomes tinged a bright violet; so that the presence of indium may be determined without the aid of the spectroscope. The fact of the reduction of the oxide with carbonate of soda or charcoal before the blowpipe has been confirmed. The metal forms a sort of ductile bead, which imparts streaks to paper on rubbing, and possesses a colour lighter than that of lead, being about the same as that of tin. The metallic bead dissolves in hydrochloric acid with evolution of hydrogen; and a platinum wire moistened with the solution exhibits in the spectroscope the blue line very strongly, although but for a few moments. MM. Reich and Richter give an account of various reactions of the new metal, and they have also ascertained in what mineral it occurs. By passing chlorine over the pure zincblende, arsenical pyrites, and iron pyrites contained in the mixed ore from which the indium had been prepared, it was found that the blende was the only one of the minerals which contained indium. The chloride of indium sublimes in the tube, and a portion of it is carried over into the wash-water, whereas the greater part of the chloride of zinc remains in the bulb. They have likewise found indium in the distilled zinc prepared from the Freiberg blende, and they have obtained the oxide from this source.—*Illustrated London News.*

Professor Roscoe has read to the Royal Institution a paper "On the New Metal Indium, and Recent Discoveries in Spectrum Analysis" (whereby, as our readers are aware, cæsium and rubidium were discovered by Bunsen, and thallium by Crookes). The spectra of all these metals were exhibited, and the new details obtained respecting their sources and properties were reported. MM. Reich and Richter found a new metal in the Freiberg zinc-blende, and named it "indium" on account of two splendid indigo-blue lines in its spectrum. The metal as yet is exceedingly rare; but, through the kindness of M. Richter, Professor Roscoe was enabled to exhibit this spectrum by placing a very small piece in the electric light. He stated that in its chemical relations it resembled zinc; that it can be reduced by the blowpipe to a malleable bead, and that it may be detected in its compounds by the deep purple tint which it imparts to flame. It will doubtless, like its predecessors, soon be detected in larger quantity in other combinations. The Professor next referred to the continuation of Kirchhoff's researches on the solar spectrum, and exhibited his maps, which showed the great progress that has been made in determining the metals to which the dark lines in the spectrum were due; adding that our knowledge on this subject was still very imperfect. The evidence of the existence of potassium in the solar atmosphere has been found insufficient upon closer examination; but the existence therein of iron, nickel, barium, copper, zinc, strontium, cadmium, &c., has been confirmed. The experiments of Mr. Huggins on the spectra of the metals, made with an instrument of six prisms, promise to add much to our knowledge. Dr. Robinson's doubts as to the validity of Kirchhoff's conclusions respecting the existence of a separate and non-coincident set of lines on the spectrum appear as yet not to be adequately sustained. Plücker's experiments have increased our imperfect knowledge of the spectra of the non-metallic elements; and he has proved that many of these elements (among them sulphur and nitrogen) exhibit two distinctly different spectra when the temperature is altered. This fact he attributes to allotropism. Professor Roscoe referred to a remarkable application of the spectroscope to the determination of the exact and very important moment when the blowing of cold air upon molten iron should cease during the Bessemer process of converting wrought iron into steel (which is effected in fifteen minutes).

In conclusion, he exhibited the brilliant light produced by the combustion of magnesium (now produced commercially by M. Sonstadt), and especially showed its richness in chemical rays, by its causing the combination of two gases with an explosion. By this light also, during the lecture, Mr. Brothers, of Manchester, took a photograph portrait of Professor Faraday, which was exhibited on a screen at the close of the evening, together with other portraits obtained in the same manner. Professor Roscoe stated that magnesium wire fitted for burning in a lamp was made by M. Sonstadt at the price of 3d. per foot; and that hopes were entertained that, eventually, the metal might become available for illuminating purposes.—*Illustrated London News.*

TINTING STEEL.

A BROWN Tint on Iron and Steel is given in Prussia in the following manner:—In as small a quantity of water as possible (about four or five parts) dissolve an equal quantity of butter of

antimony, or chloride of antimony, which may retain the least possible quantity of hydrochloric acid (for it is in the proportion of this acid that is found the success of the operation), and one part of gallic acid. With a sponge or piece of stuff which has been moistened with this liquid the iron or steel is rubbed for several times, being left to dry in the air between each rubbing: finally, the metal is rubbed with boiled linseed oil. The tint is more or less deep in proportion to the number of rubbings. While an agreeable appearance is given to the metal, it is, at the same time, preserved from the action of rust.

THALLIUM KNOWN TO THE ANCIENT MEXICANS.

It is reported upon good authority, says the *Mining Journal*, that a distinguished German chemist has just made an important discovery in connexion with the alloy now generally designated Thallium. It appears that among the most ancient records of the ancient Mexicans an account is given of the mode of preparing the alloy used for producing the brilliant green fire which was freely burnt during the sacrificial ceremonies in honour of Vitzipultzi, one of their principal deities; and that in the attempt to prepare a similar alloy, from the details given, a discovery opening an entirely new field of chemical science has been made. By the peculiar treatment of certain proportions of silver, lead, and selenium, a black powder was produced, so much resembling that designated thallium, that the experimenter was induced to test it. The weight of alloy was precisely equal to that of the metals used; yet the whole of the reactions of thallium were obtained, and salts, bases, and acids of the alloy were produced, precisely as if the alloy had been a perfect metal. Even in the spectroscope the well-known green line was produced. It is anticipated that some tons of thallium will shortly be ready for sale in England at less than the price of silver.

THE LIQUID COMPASS.

Professor W. B. Rogers has read to the British Association a paper, in which, after a reference to the spectroscope, stating that Professor Cook was preparing to substitute glass for the bisulphate of carbon in his spectroscope, Mr. Rogers proceeded to describe, illustrated by diagrams, Ritchie's improvements in the Liquid Compass, as adopted in the American monitors. The principle of the improvement appears to be the use of a float filled with a liquid compound of water and alcohol, with a band of needles so placed that the disturbance arising from the oscillating motion of the ship is reduced, as the Professor stated, almost to zero. As showing the efficiency of this invention, the Professor added that he had seen one of these compasses taken by a porter, who ran with it backwards and forwards, up and down, from side to side of a rough floor, without any perceptible variation in the accurate pointing of the needle; and it might be swung round and round, and backward and forward, in the hand, without causing any deviation beyond half a point.

HICKS'S PATENT MAXIMUM MERCURIAL THERMOMETER

Is figured and described in the *Mechanics' Magazine*. The principle consists in constructing the Thermometer with a short tube, or mercurial chamber, carried from the side of the ordinary column tube near the bulb; the bore of this short tube or chamber is larger than that of the column tube, and the action is as follows: The thermometer is set by the bulb end being held downwards, to allow the short tube or supplementary chamber to become full; it is then placed in position horizontally, with the short tube or supplementary chamber uppermost. Any increase in temperature will cause the column of mercury to rise in the ordinary thermometer tube; then, upon a decrease in the temperature taking place, the column will remain at the maximum, and mercury will descend from the short tube or chamber.

NEW ANEMOMETER.

Mr. Glaisher (for Mr. Cater) has read to the British Association a paper explaining the construction of a New Anemometer for registering more accurately the force and pressure of the wind.

Mr. Osler took exception to some of the details of the new instrument, and contended for the superiority, in some respects, and equality in all, of the Liverpool and the Royal Exchange instruments.

Mr. Scott Russell asked whether any unit of pressure had been determined for any given pressure of wind? He had made experiments with the anemometer he used, and found that the unit was, plus pressure, almost exactly 1 lb. at 20 miles an hour, and 9 lb. at 60 miles an hour. Mr. Glaisher had distinctly stated that he could not connect pressure with velocity.

Mr. Scott Russell had found that 10 miles, 1 lb. increasing according to the square of the velocity, was a close measure to the plus pressure on a surface. He had proved the accuracy of this by Peto's tube on railways at 60 miles an hour, and had measured it in storms at $7\frac{1}{2}$ lb. plus pressure. He suggested that observations should be made of the results in different anemometers, with a view to arriving at accuracy.

NEW THERMOGRAPH.

M. Marcy has addressed to the French Academy of Sciences this description of an instrument for marking small variations of temperature. It may, we believe, be rendered intelligible without a diagram. 1. The first part of this Thermograph consists of a copper tube a metre in length, the interior diameter of which is capillary, not being more than one-fifth of a millimetre.

It is open at one end, and soldered to a hollow copper ball at the other. 2. The second part of the apparatus consists of a wheel resting upon knife-edges, like those of a pair of scales, whereby a very delicate oscillation may be imparted to it. The axle of the wheel carries a long vertical needle, marking the degrees on a circular scale. To the circumference of the wheel is fixed a glass tube six millimetres in diameter, and bent in conformity to the curvature of the wheel, and so situated that the middle of the tube lies vertically underneath the needle when the wheel is at rest. One of its extremities is hermetically closed, while the other is open. Now, if a little mercury be poured into this tube it will settle at the lowest point, and the interior of the tube will thus be divided into two chambers, one closed and with air confined in it, the other open. 3. Now introduce the copper tube into the glass one, giving it of course the same curvature, and so that its extremity may pass through the mercury, thus establishing a communication between the hollow copper ball and the confined chamber, and the apparatus, with a few accessory appliances, will be complete. The end of the copper tube dipping into the mercury should be varnished to prevent its being attacked by the latter metal; or better still, the end might be made of platinum. 4. To use this apparatus, put your hand to the copper ball; the warmth thus imparted to it will dilate the air it contains, and drive part of it into the confined chamber; the mercury will therefore recede, and thereby make the wheel turn round its centre of gravity; the very small arc thus described will be revealed by the needle, the difference of its present position with its previous one when at rest. If, on the contrary, the copper ball be cooled, by water, for instance, the air inside will be contracted, a portion of the air of the confined chamber will rush in, and the mercury will be driven forward, the needle turning in the inverse direction. By means of this apparatus very delicate physiological experiments on animal heat may be conducted.

INITIAL PRESSURE OF STEAM.

SOME years ago, Mr. R. A. Peacock had occasion to attempt to calculate the probable Pressure of Steam at the highest known temperatures, and found, amongst other things, that between the pressures of 25 lb. per square inch and 300 lb. to the square inch, the latter being the highest pressure to which trustworthy experiments had been carried, the law of increase was approximately: That the temperature of high-pressure steam of, say, 25 lb. to the square inch and upwards, increases as the $4\frac{1}{2}$ root of the pressure; and that, conversely, the pressure of the steam of, say, 25 lb. to the square inch and upwards, increases as the $4\frac{1}{2}$ power of the temperature. At lower pressures than about 25 lb. per square inch a different law prevails. As it is necessary to verify the new formula by comparison with some well-known formulæ and experiments, the author has attempted to do so in a very voluminous table, and graphically in a very carefully-executed diagram. What is to be gathered from these is, that the new formula agrees with Dr. Fairbairn's experiments, from about 40 lb. to 60 lb., and very nearly with Regnault's, between 220 lb. and 336 lb.—*Proc. British Association.*

WATER BOILED IN PAPER VESSELS.

M. TERREIL has laid before the Chemical Society of Paris facts proving that the Paper on which a layer of Water is placed may be heated to the highest temperature without being changed. Details will be found in the Bulletin of the Society, which now includes the publication formerly entitled the *Repertoire de Chimie*. The paper employed by M. Terreil was ordinary writing-paper. He states, in conclusion, that the non-conductibility of the paper for heat and the constant evaporation of the liquid through the pores of the paper prevent the combustion of the paper, and the ebullition of the water when heated in vessels of paper. During the experiment there is endosmosis of the exterior gases through the pores of the paper: hence, when the water contains metallic salts in solution, those are reduced by contact with the flame, after having traversed the paper.

MOLECULAR PHYSICS.

PROFESSOR TYNDALL has read to the Royal Institution "Contributions to Molecular Physics," the chief points of which are thus reported in the *Illustrated London News*:—A molecule is a union of atoms (e.g., watery vapour is an aggregation of molecules composed of atoms of oxygen and hydrogen, held together by the attraction of cohesion). The degree of this attraction varies with temperature: hence the three states of water—solid, liquid, and gaseous. To measure the action of radiant heat special apparatus has been constructed, and its transmission through numerous liquids and vapours and their absorptive powers very accurately observed by the Professor. It has been proved that substances which are transparent to light are very frequently opaque to the rays of heat—e.g., water, in all its forms, being a special example of opacity to heat rays, while bisulphide of carbon of all liquids is the most transparent to heat rays (diathermanous). Dr. Tyndall's researches have shown that the absorption and radiation of heat are phenomena independent of the state of aggregation of a body. This has been proved by the examination of the absorption of heat by a number of liquids, and also by the vapour of those liquids. In both cases the same source of heat was employed, and the order of absorption for liquids and vapours was found to be precisely the same when "equal quantities" of the two substances are used. The different coloured rays of the spectrum are due to the different wave-lengths of the luminiferous ether; the waves of the red end being much longer than those of the blue end. A fine electric light spectrum was introduced on a screen, and the invisible violet

rays were exhibited by means of paper saturated with a solution of sulphate of quinine. By introducing into the path of the rays a glass cell filled with this solution it was shown that the liquid itself became luminous, casting a dark shadow on the previously illuminated screen—this phenomenon being due to the retention of the fluorescent rays by the solution. The same effect was produced for the invisible rays at the red end of the spectrum by a solution of alum, which completely cut off the heat-rays and allowed the light to pass freely. The reverse of this was then shown by means of a solution of iodine in bisulphide of carbon, which allowed the heat-rays to pass through, but intercepted the whole of the visible spectrum. The cause of this opacity has been proved to be due to the coincidence in the periods of vibration of the radiating and the absorbing body. It was also shown that the radiation from a hydrogen lamp was completely cut off by a layer of water only the 700th of an inch in thickness. This also Dr. Tyndall attributed to the synchronism between the radiating aqueous vapour of the hydrogen flame and the water. The same effect is produced when the radiation of carbonic oxide is passed through carbonic acid. All these facts show that the radiation and absorption of heat are dependent on molecular phenomena and completely isolated from mere temperature, as shown by the two last-mentioned experiments. In conclusion, Dr. Tyndall pointed out as a conclusion derived from his experiments that the radiation which takes place at night, being mainly from the dew covering the surface of the earth, must be completely stopped by the aqueous vapour present in the atmosphere, nocturnal radiation being thereby prevented from escaping into space, and the temperature of our globe being thus maintained.

In the *American Journal of Science*, Professor W. A. Norton sets forth a physical theory of molecular phenomena, "based upon the highest generalisation and the most reliable physical conceptions to which the progess of science has conducted." Our limited space prevents us from going into detail, and we merely give "the established truths and generally received ideas" upon which the author bases his theory, as follows:—1. All the phenomena of material nature result from the action of force upon matter. 2. All the forces in operation in nature are traceable to two primary forces—viz., attraction and repulsion. 3. All the bodies of matter consist of separate indivisible parts, called atoms, each of which is conceived to be spherical in form. 4. Matter exists in three different forms, essentially different from each other. These are—(1) Ordinary or gross matter, of which all bodies of gross matter directly detected by our senses, either wholly or chiefly, consist. (2) A subtile fluid, or ether, associated with ordinary matter, by the intervention of which all electrical phenomena originate or are produced. This electric ether, as it may be termed, is attracted by ordinary matter, while its individual atoms repel each other. (3) A still more subtile form of ether, which pervades all space, and the interstices between the atoms of bodies. This is the medium by which light is propagated, and is called the luminiferous ether, or the universal ether. The atoms, or "atomettes," of this ether mutually repel each other; it is attracted by ordinary matter, and is, consequently, more dense in the interior of bodies than in free space. 5. Heat, in all its recognised actions upon matter, manifests itself as a force of repulsion. The corner-stone of a physical theory of molecular phenomena (says Professor Norton) must consist in the conception that is formed of the essential constitution of a single molecule; understanding by a molecule an atom of ordinary matter, endued with the properties and invested with the arrangements which enable it to exert forces of attraction and repulsion upon other molecules. According to the Professor, the molecular forces consist of—1. A repulsive action of the electric atmosphere of a molecule exerted primarily upon the electric ether immediately exterior to it. 2. An attractive action exerted by the central atom of the molecule upon the electric ether surrounding it, originating a series of successive contractions of this atmosphere; and thus of inward-acting impulses, which are propagated outward and form a set of attractive waves. 3. A third molecular force then consists of a series of repulsive or outward acting impulses imparted to the universal ether at the surface of the atom of a molecule by the contractile force exerted by the atom upon its electric atmosphere. This repulsion is equal, at its origin, to the attraction which develops it. The author then compares his theory with those of Tyndall and other philosophers who have studied this recondite subject. Professor Norton's Memoir is reprinted in the *Philosophical Magazine*.

PROPERTIES OF CRYSTALS.

Mr. A. Cotton has read to the British Association a paper on the connection between the form and optical Properties of Crystals. It was believed that in the results obtained, the principal difficulties on the subject had been overcome. After referring to the labours of Sir David Brewster, by whom the first steps towards the solution of this problem had been made in 1818, the author stated that he had as yet only applied his theory to crystals of the prismatic system. He described the problem as follows:—Given the angular element of a crystal belonging to the prismatic system, to find the angle between the optic axes," and proceeded to give the formula for the solution of the problem, which is of too technical a character to reproduce. But by a comparison of this formula with experiments, it was found that in all cases the calculated agreed with the observed angle between the axes. The author said that he was now extending his system to the oblique, and another system.

The President of the Section remarked on the importance of the paper, especially as it was shown that the author's formulæ agreed with matured observation.

COHESION OF LIQUIDS.

Dr. Stritbill Wright has read to the Royal Scottish Society of Arts, at Edinburgh, a paper giving an exposition of the late researches on the Cohesion Figures of Liquids. The phenomena resulting from the cohesion of fluids appeared to Dr. Wright to be important, and likely at some future time to lead to practical results, especially to the pharmaceutical chemist, and the medical man; whilst the beauty and strange shapes of the figures would afford to the pattern-designer, a perfect kaleidoscope of infinite variety in form and colour, free from the mathematical precision and stiffness of the celebrated instrument of Brewster. Other philosophers had observed figures produced on mercury, glass, &c., by dropping sulphuric acid and other fluids gently on their surfaces; but it was reserved for Tomlinson to discover that each liquid had a characteristic figure of its own, and he at once perceived that he was able to place in the hands of the chemist a new and ready method of qualitative analysis, which in some cases rivalled in beauty and delicacy the celebrated spectrum analysis of Kirchhoff. By this method, for instance, it was possible to detect in an instant the adulteration or alteration by age of various oils and drugs, where other means of analysis would be attended with great difficulty or delay. The adulterations in oils might be recognised by their cohesion-figures, and the amount of adulteration ascertained by comparing them with mixtures of oils made for that purpose.

Mr. C. Tomlinson has communicated to the British Association a paper "On the Cohesion Figures of Liquids," which subject was introduced to the Association at Manchester, in 1861. The author now stated the progress which had been made since that time, and introduced two new sets of figures. The principle of the examination by this method, is to place a drop of a liquid on the surface of clean water in a chemically clean glass, when a figure is produced which was characteristic of the liquid so tested, and capable of being used for its identification. The figure formed is a function of cohesion, adhesion, and diffusibility. If any one of these forces be varied, the figure varies. The figures of alcohol for example on water, mercury, the fixed oils, melted lard, spermaceti, paraffin, sulphur, &c., are all different. A new set of figures is produced by allowing the drop to subside in a column of liquid instead of diffusing over its surface. These last the author calls "submersion figures of liquids." The figure of a drop of oil of lavender in a column of alcohol thus produced is singularly complicated and beautiful. The test by cohesion figures was stated by the author to be so delicate as to readily distinguish differences between oils so closely related as the oleines of beef-fat and mutton-fat, when the one was adulterated by the other.

DROP MEASURE.

The size of a Drop of liquid is often spoken of as a definite quantity. In a paper on this subject by Mr. Tate, in the *Philosophical Magazine*, it is shown that not only the size but the weight varies with the diameter of the tube, and the density, temperature, and chemical composition of the liquid itself. He gives the results of experiments which show that—1. Other things being the same, the weight of a drop of liquid is proportional to the diameter of the tube in which it is formed. 2. With regard to capillarity, the weight of the drop is in proportion to the weight of water which would be raised in that tube by capillary action. 3. The augmentations of weight are in proportion to the diameters of the surfaces on which the drops are formed. 4. The weight of a drop is diminished by an augmentation of temperature. 5. Independent of density, the chemical composition of a liquid affects the weight of its drop in a remarkable manner. 6. In different solutions of common salt and other natural salts, the augmentation in the weight of the drop is in proportion to the weight of dry salt in solution. The foregoing principles are supported by tabulated statements.

BLOOD CORPUSCLES.

Dr. Crisp has read to the British Association a paper "On the Size of the Blood-Corpuscle, in relation to the Size of the Animal, its Organization, and Powers of Endurance." The object of this paper was to show that the opinion generally entertained, that the largest animals in the same family have the largest blood-globules, is erroneous in many instances. Examples were given among the quadrumana (apes and monkeys) of exceptions to this supposed law: thus the little Marmoset and Silky Tamarm have corpuscles as large as those of the larger monkeys. Among the Cheiroptera (bats), similar examples were given. In the *carnivora*, the common cat has a corpuscle as large as that of the lion or tiger. In the rodents, the little harvest-mouse has as large a blood disc as the common rat, or gigantic rat. In the other orders the great kangaroo, tree kangaroo, giraffe, tapirs, hogs, ass, horse, and many others, were advanced as disproving the correctness of this assumed law; and it is a curious fact that all the mammals with large blood-corpuscles might be called aberrant, such as the elephant, cassybara, and great ant-eater. Among birds, the ducks, swans, geese, and many others afford exceptions, and the reptiles are still more prolific in examples; thus the little slow-worm, as Dr. Crisp had shown in 1854, has corpuscles as large as those of the huge Python, weighing 100 lb. In fishes the blood-discs of the little gudgeon are as large as those of the big bream. The mackerel's blood-corpuscle is as large as that of the huge tunny, and that of the small trout equals in size the blood corpuscle of the salmon. In answering the question whether the size of the corpuscles was smaller in animals of higher organization and greater powers of endurance, the orang, chimpanzee, and many of the smaller monkeys, race-horse, cart-horse, greyhound, pug-dog, hare, rabbit, goat, otter, fox, sheep, hog, rapa-

cious birds, slow-worm, python, sharks, and others, were adduced to show that this opinion was incorrect. As regards the size of the blood-corpuscle, it is not to be wondered at that a large animal has a large blood-corpuscle; but it is surprising that one little harvest mouse should have a blood-disc as large as that of the giraffe; and that the blood-disc of the tiny marmoset monkey, weighing 9 oz., should equal in diameter that of the large baboon, exceeding the weight of 60 lb.! The blood-corpuscles of 180 animals (drawn to scale) were exhibited.

SUCCESSION AND DEVELOPMENT OF ANIMAL ORGANIZATION.

The Succession and Development of Animal Organization on the Surface of our Globe in different periods of its existence is the subject of some remarks by M. J. Van der Hoeven, the able Professor of Zoology in the University of Leyden, which have been translated from the Dutch by Dr. Barnard Davis, and inserted in the *Annals of Natural History*. The article is very interesting, as having been written prior to the appearance of Mr. Darwin's celebrated *Origin of Species*. The Professor gives a summary of the history of the question, referring to the opinions of Bonnet, De Maillet (author of the singular book *Telliamed*, his own name spelt backwards), Lamarck, and others. Lamarck's views include his notion that habits form a new nature, and that even passions may produce such alterations. He thought it probable that fits of anger in Ruminants produced congestion in the forehead; and that by striking each other when they fought, a greater secretion of osseous substance and a production of horny matter might be provoked, by which means they at last acquired horns! The following notes express Professor Van der Hoeven's opinions:—"It would require nearly a perfect abnegation of all knowledge gathered by observation if we did not admit these fundamental results of palæontological investigations—first, that there existed formerly on our planet other species of plants and animals than those now living; and, in the second place, that the now living species of plants and animals did not exist from the beginning of life on earth. . . . That some species become extinct seems in general a fact that is not so strange as that some species originated in succession—that there were consecutive and distinct creations of organic forms. Of the first fact we do not want examples, even in recent periods—within the three last centuries of history [such as the extinction of the dodo, the disappearance of the lion, beaver, &c., from Europe]. . . . That there was a succession of new species of plants and animals, a repetition of distinct creations, is a conception which seems not so favourable to acceptance. There is nothing, indeed, in actual observation of the present order of nature that can be compared to this new creation. . . . But, whatever is stated on the chronology of the acts of creation, the investigation must, of course, end in the admission of some first origin, concerning which science cannot say anything, save the sublime and simple words of the first verse of the first book of the Bible, 'In the beginning God created the heavens and the earth.' . . . Creation, the first origin of things, is, and always will be, a mystery; the mystery is by no means elucidated if we assume germs. The first animal, for instance, that possessed organs of vision has to be derived from another without eyes. But why should such a supposition seem clearer and more intelligible than the creation of an entire animal provided with eyes? Here Science does not shut her books, as it has been said by some; true Science never opened her books on such questions."—*Illustrated London News.*

HYBRIDITY AND VARIABILITY.

M. Naudin has read to the French Academy of Sciences a paper "On Hybridity considered as a Cause of Variability in Vegetables." The experiments and the results detailed merit the particular attention of botanists and horticulturists. The general result, however, appears to be what has been before observed: namely, that whatever variations may be produced, no permanently new species are obtained by crossing the plants.

THE MUSCLES.

The Muscles connected with the Hair and Feathers have been studied by M. Seuffert. The number of these muscles found in the skin of mammals which have hair varies in proportion with its quantity. The muscles of the piliferous follicles form elongated bands, springing from the surface of the derm, and inserted in the base of the follicles; and there always exists a relation between these muscles and the sebaceous follicles of the skin. These muscles also produce the movements which cause erection of the hair. These same muscles are spread over the skin of birds, and exercise the same functions with feathers as they do with the hair of mammals. The fibro-cellules of these muscles, with their great ovoid nucleus, are united into large muscular bands, which form a system completely distinct from the striated muscles placed under the skin.

ACTION OF OXYGEN GAS ON ANIMALS.

In a paper addressed to the Academy of Sciences, Drs. Demarquay and Leconte have examined the action of Oxygen on animals. They state that dogs can inhale from 30 to 40 litres of that gas and more, without evincing any other effect but that of great liveliness and an increase of appetite. But in order to observe the effects which oxygen thus inhaled produced on the body, large incisions were made on dogs in the axillary region, and when these were in course of healing the dogs were made to inhale oxygen. It was then perceived that the wound was strongly injected; that a transparent serum exuded from the wound, and

that in course of time a quantity of petechiæ made their appearance. Hence oxygen administered by inhalation exercises a powerful action on wounds. Oxygen injected into the jugular vein produced the same effects. These experiments require great care in order to prevent the death of the animal; but our authors have found that the injection may be most safely performed on the vena cava below the liver and on the vena porta. In this way upwards of two litres were injected without causing the death of the animal, and without producing any modification in the blood. The milt alone turned red, and the abdominal veins became turgid, as if, under the influence of oxygen, the mass of the blood had been increased. Rabbits were found to live seventeen hours in oxygen, and after their death all their muscles were in a turgid state; the venous and arterial blood had undergone no change of colour, and no organ displayed any signs of inflammation.

SPONTANEOUS GENERATION.

In the *Proceedings of the Royal Society*, No. 65, is inserted an account of the result of twenty experiments relating to this question, performed by Dr. G. W. Child. The substances used were, in ten experiments, milk; and in ten, fragments of meat and water. These were in all cases placed in a bulb of glass about 2½ in. in diameter, and having two narrow and long necks. The experiments were divided into five series of four experiments each. In one series the bulbs were filled with air previously passed through a porcelain tube containing fragments of pumice-stone, and heated to vivid redness in a furnace. In the others they were filled respectively with carbonic acid, hydrogen, oxygen, and nitrogen gases. In each series two experiments were made with milk and two with meat; and each substance was boiled in one case and not boiled in the other. The joints of the apparatus were formed either by means of non-vulcanized caoutchouc tubing, or India-rubber corks previously boiled in a solution of potash; and in every case, at the end of the experiment, the necks of the bulb were sealed by the lamp. The time of boiling such of the substances as were boiled varied from five to twenty minutes, and the boiling took place in the bulbs, and with the stream of gas or air still passing through. The substances were always allowed to cool in the same stream of gas before the bulbs were sealed. The microscopic examination of the contents of the bulbs took place at various times, from three to four months after their inclosure. In every case but one in which the substance had not been boiled, low organisms were found, apparently irrespective of the kind of gas in which they had to exist. The case in which they were not seen was that of the meat inclosed in a bulb filled with nitrogen. This bulb burst apparently spontaneously, and its doing so may be looked upon as a proof that in it also some change had taken place, most likely connected with the development of organic life. Dr. Child concludes by saying that no definite conclusion can be drawn from so limited a range of experiments; but it is worthy of remark, that organisms were found here under the precise circumstances in which M. Pasteur states that they cannot and do not exist. The very abnormal conditions under which some of these so-called organisms are found would render it doubtful whether bacteriums, vibrios, &c., ought to be considered as independent organisms in any higher sense than are white blood-corpuscles, pollen grains, mucus corpuscles, or spermatozoa.

At a meeting of the Academy of Sciences at Paris, M. Pasteur has reverted to the controversy on this subject. In his recent memoir he stated, on the faith of numerous experiments, that it was always possible to take away from any determined spot a limited, yet notable, amount of air which has not undergone any physical or chemical change, and which was, nevertheless, quite unable to provoke any alteration in an eminently putrescible liquid. MM. Pouchet and Joly having affirmed that this result was erroneous, M. Pasteur defied them to prove it so. MM. Joly and Musset said, "If a single one of our tubes remain unaltered, we will loyally acknowledge our defeat;" and M. Pouchet also said, "I declare that, on any part of the globe whence I shall take a cubic decimetre of air, when I shall place it in contact with a putrescible liquid in a hermetically sealed tube, the latter will invariably become filled with living organisms." In conformity with the demand of MM. Pouchet, Joly, and Musset, accepted by M. Pasteur, the Academy has appointed a committee composed of several of its most illustrious members—MM. Flourens, Dumas, Brongniart, Milne-Edwards, and Ballard, to repeat in its presence the experiments, the results of which have been invoked as either favourable or contrary to the doctrine of spontaneous generation.

THE MAGNETIC FORCE.

At the Royal Institution, Professor Tyndall has given "A Magnetic Experiment," in course of which he demonstrated that a magnetized bar of iron becomes elongated, not shortened, at the moment of magnetization. He also showed, that when rapidly intermitting currents of electricity were sent through the wire, a humming sound was distinctly heard in the iron bar, occasioned, as he conceived, by the momentary changes among the particles of iron as the magnetic power was imparted and lost. The lengthening of the bar was shown to the sight by help of a lever acting on a small mirror and a ray of light, so as to show very minute changes in the length of the iron bar. Dr. Tyndall accounted for the lengthening by the hypothesis that the particles of iron tend to arrange themselves in the direction of the current, which passes lengthwise through the iron bar. The experiment of the arrangement of loose particles of oxide of iron suspended in water was exhibited, showing that, when magnetized, the opacity arising from confusion was replaced by translucency from the magnetic arrangement of the particles in lines. May not this shed a light on translucency and transparency in general, as of crystals and glass?—*Builder*.

The following are the details of the preceding experiment:—

Prof. Tyndall began by exhibiting the leading grand phenomena of magnetism and electro-magnetism by means of the powerful apparatus of the Institution. He then proceeded to repeat and explain Mr. Joule's experiment, which showed that, when a bar of soft iron is magnetised, a sound is produced, due to the vibration of the particles; and he made this sound audible throughout the theatre by means of a monochord. After dilating on the recondite physical changes which take place in the internal constitution of bodies due to magnetic and electric action, he entered upon the main subject of his lecture, Mr. Joule's experiment, which has proved that, when a bar of iron is magnetised, it is actually elongated; and by repeating the experiment in an enlarged form, aided by apparatus devised by himself and skilfully constructed by Mr. Becker, consisting of a system of levers, with a reflecting luminous index, the Professor made this elongation clearly manifest to his audience. He then, by strewing iron filings upon paper, placed over a powerful magnet, exhibited the magnetic curves or lines of force taken up by the filings when magnetised; and suggested that the elongation of the bar of iron was probably due to its particles setting their longest dimensions parallel to these lines of force—that is, to the length of the magnet. He also performed an ingenious experiment, devised by Mr. Grove, but never before exhibited, whereby the supposed motion of these particles was made visible. Professor Tyndall stated that he had not been successful in his endeavours to produce this elongation in a diamagnetic body (in the case of a bar of bismuth); and concluded by remarking that the world knew and appreciated the great and successful results obtained by philosophers, but could not sufficiently estimate the large amount of failure and disappointment which they had to endure in their most favourite and profound researches.

DIAMAGNETISM.

PROFESSOR MAAS, of Namur, in a communication made to the Royal Academy of Sciences of Belgium, expresses his opinion that water is the determining cause of the Diamagnetism of certain organized substances. He states that Faraday, in his work on magnetism, has ranged elder-pith and ivory among diamagnetic bodies. After having observed the diamagnetism of a small prism of elder, he was surprised to find it changed to para-magnetism a short time afterwards. In order to ascertain the cause, he cut from a long cylinder of oldish elder-pith two prisms, using a knife electrotyped with copper. One of these prisms was left exposed to the air, the other was inclosed in a flask containing some drops of distilled water. The first was found to be powerfully axial-magnetic, the other as powerfully equatorial. M. Maas hence concludes that the water made the latter diamagnetic. Several slices of ivory cut in different directions from an old piece equally surprised him, since none placed itself across the axis of the magnet; one placed itself axially; another made a very open angle with the same axis. A third example was a small cylinder composed of starch, gum arabic, and water. Freshly prepared, it placed itself transversely, but when spontaneously dried it became para-magnetic. "Hence," says M. Maas, "we may be permitted to suppose that many natural organic substances owe their diamagnetic property to the interposition of liquids, of which water forms the larger proportion." The apparatus employed in the experiment was a Faraday's electro-magnet, modified by Becquerel and constructed by Secretan.

MAGNETIC STORMS.

THE first analysis of 177 Magnetic Storms, recently laid before the Royal Society by the Astronomer Royal, Mr. G. B. Airy, is printed in No. 59 of the Proceedings of the Society. In regard to the physical inference to be derived from the numerical conclusions obtained from tables exhibiting the algebraic sum of fluctuations for each storm, the aggregate or mean for each year, and for seventeen years, the number of irregularities for each year and for the whole period, &c., Mr. Airy expresses his strong opinion that it is impossible to explain the disturbances by the supposition of definite galvanic currents, or definite magnets, produced in any locality whatever. He suggests that the relations of the forces found from his investigations bear a very close resemblance to what might be expected if we conceived a fluid (to which, for facility of language, the name "magnetic ether" is given) in proximity to the earth, to be subject to occasional currents produced by some action, or cessation of action, of the sun, which currents are liable to interruptions or perversions of the same kind as those in air and water. He shows that in air and in water the general type of irregular disturbance is travelling circular forms, sometimes with radial currents, but more frequently with tangential currents, sometimes with increase of vertical pressure in the centre, but more frequently with decrease of vertical pressure; and, in considering the phenomena which such travelling forms would present to a being over whom they travelled, he thinks that the magnetic phenomena would be in great measure imitated. Mr. Airy recommends that observations be made at five or six observatories spread over Europe, and would prefer self-registering apparatus, provided that its zeros be duly checked by eye observations, and that the adjustments of the light give sufficient strength to the traces to make them visible in the most violent motions of the magnet.—*Illustrated London News.*

PERILOUS ADVENTURE.

PROFESSOR TYNDALL describes a Perilous Adventure in his recent ascent of the Piz Morteratsch, when Dr. Tyndall and five of his companions, by the sudden detachment of an avalanche, were carried back with terrific speed, crossing crevasses, &c. Happily, it was brought to rest within a short distance of chasms over which, had they preserved their speed, a few seconds would have carried them. Strange to say, none of them sustained serious damage. Describing his sensation while being whirled along, the Professor says:—"A kind of condensed memory, such as that described by people who had narrowly escaped drowning, took possession of me; and I thought and reasoned with preternatural clearness as I rushed along. Our start, moreover, was too sudden and the excitement too great, to permit of the development of terror."

Electrical Science.

ELECTRICAL FORCE.

SIR W. SNOW HARRIS has laid before the Royal Society "Further Inquiries on the Laws and Operation of Electrical Force." He refers to the experiments of Le Monnier, Cavendish, and Volta, as showing that bodies do not take up electricity in proportion to their surfaces, and to the opinion of Volta, that a plane surface extended in length sustains a greater charge; and that this is attributable to the electrical particles being further apart upon the elongated surface, and consequently further without each other's influence. Sir Snow Harris endeavours to show that in extending a surface in length we expose it to a larger amount of inductive action from surrounding matter. No very satisfactory experiments seem to have been instituted showing the relation of quantity to surface. On a further investigation of the laws of electrical charge, the quantity which any plane rectangular surface can receive under a given intensity is found to depend not only upon the surface, but also on its linear boundary extension. Hence, the charge of the rectangle is much greater than that of the square, although the surfaces are equal, or nearly so. It is from a rigid experimental examination of this question that electrical charge depends upon surface and linear extension conjointly. Every plane surface seems to have what may be termed an electrical boundary, having an important relation to the grouping or disposition of the electrical particles in regard to each other and to surrounding matter. This boundary, in circles or globes, is represented by their circumferences. In plane rectangular surfaces it is their linear extension, or perimeter. We give a concise description of Sir Snow Harris's hydrostatic electrometer, as recently perfected and improved, which has been so essential to the successful prosecution of his researches. In this instrument the attractive force between a charged and neutral disc, in connection with the earth, is hydrostatically counterpoised by a small cylinder of wood accurately weighted and partially immersed in a vessel of water. The neutral disc and its hydrostatic counterpoise are freely suspended over the circumference of a light wheel of 2·4 inches in diameter, delicately mounted on friction wheels, so as to have perfectly free motion, and be susceptible of the slightest force added to either side of the balance. Due contrivances are provided for measuring the distance between the attracting discs. The balance-wheel carries a light index of straw reed, moveable over a graduated quadrantal arc, divided into 90 deg. on each side of its centre. The neutral attracting plate of the electrometer is about $1\frac{1}{2}$ inch in diameter, and is suspended from the balance-wheel by a gold thread over a similar disc, fixed on an insulating rod of glass, placed in connection with any charged surface the subject of experiment. The least force between the two discs is immediately shown by the movement of the index over the graduated arc on either direction, and is eventually counterpoised by the elevation or depression in the water of the hydrostatic cylinder, suspended from the opposite side of the wheel. The divisions on the graduated quadrant correspond to the addition of small weights to either side of the balance, which stand for or represent the amount of force between the attracting plates at given measured distances with given measured quantities of electricity. This arrangement is susceptible of very great accuracy of measurement.

TERRESTRIAL MAGNETISM AND ELECTRICITY.

FATHER SECCHI, of Rome, has communicated to the French Academy of Sciences a memoir on the currents of the earth and their relation to the phenomena of Electricity and Magnetism. (*Comptes Rendus*, Vol. 58, No. 26.) Our space will not suffice for an account of the experiments and calculations which led him to conclude that the variations of the currents of magnetized bars and of atmospheric electricity may be derived from the same principle in motion; that we should not confound this action with that of the heating action of the sun, but that we should rather be led to recognise in it a species of daily electric flux and reflux, allied to the solar action, the energy of which, in this transformation, is manifested in a manner different from that of heat and light. The opinion put forth by M. De la Rive, that the diverse variations of the bars may be derived from atmospheric electricity, seems thus to acquire great probability.

LIGHTING GAS BY FRICTIONAL ELECTRICITY.

MESSRS. CORNELIUS & BAKER have exhibited at the Franklin Institute, Philadelphia, some ingenious apparatus, constructed on the principle of the electrophorus, for Lighting Gas. A bracket is arranged with a brass cup or vase resting upon it, with a connecting piece of hard rubber. The cup is lined with lambskin covered with silk, and contains the hard rubber electric piece which corresponds in form to the inside of the cup. A coiled covered wire connects the cup with a wire attached to the burner, and terminating just above the burner. In order to light the gas the stop is turned, and the hard rubber piece lifted partly from the cup, thus liberating the spark and lighting the gas. A portable lighter was also shown, consisting of the same vase or cup, with the addition of a non-conducting handle. When the brass cup is lifted from the electric piece and held to the conducting wire of the burner, the gas is immediately lighted.

VELOCITY OF ELECTRICITY.

THE Velocity of Electricity and the duration of the spark have been made the subject of experiment with new apparatus by

M. Felici, of Pisa, and described in the *Cimento*. He has determined the velocity to be 260,000 kilometres per second. The following are the determinations of other philosophers:—Wheatstone, 480,000 kilometres; Fizeau and Gounelle, 180,000 kilometres; the astronomers of London and Edinburgh, 12,200 kilometres; those of Brussels, 4300 kilometres. The kilometre is 0·6213 mile.

GROVE'S GAS-BATTERY.

A THEORETICAL consideration of the arrangements and action of this Battery leads Mr. Malone to suggest, in the *Philosophical Magazine* for January, 1864, that antecedent static action is necessary to produce true voltaic phenomena. The gas-battery of Mr. Grove consists of a series of cells, each containing two tubes of glass sealed at one end; and in which are inserted, by fusion, long narrow platinum plates and attaching wires, the plates reaching a little below the bottom of the tubes. These tubes are partly immersed, by means of a ground collar, into a square three-necked Woulfe's bottle, the centre hole between the tube-holes being stoppered. The tubes are usually two-thirds filled, the one with hydrogen, two volumes,—the other with oxygen, one volume—the bottle and remaining part of the tube holding the usual dilute sulphuric acid to complete the circuit. The platinum is, in order to promote contact with the respective gases and the liquid, covered with platinum-black. Metallic contact between the tubes, or to the galvanometer, is made by mercury cups attached to the platinum wires.

ELECTRO-CHEMICAL ENGRAVING ON METAL.

A PAPER, "On a Method of Instantaneous Engraving on Metal," has been read at the Society of Arts, by M. Vial, of Paris. He described various modifications of his discovery, which are patented. In one case, a drawing in metallic ink is laid damp upon a zinc or steel plate, and pressed for two minutes, when the design is transferred to the plate. In another case, an engraving on paper is saturated with a metallic solution, as of copper, and laid upon a zinc plate, and pressed, when the copper is precipitated in a few moments over the plate, except where the greasy ink covers the paper. After a farther process positive plates are taken from these negatives by means of printed impressions. A third process consists in drawing on a steel plate with greasy ink, and plunging it into a copper solution, containing a little nitric acid. This also is perfected by a subsequent process. In the discussion on the paper the processes were generally admitted to be of value and importance.

VOLTAIC ELECTRICITY—NEW CALORIC BATTERY.

MR. JAMES DICKSON has read to the Inventors' Institute a paper "On Certain Inventions for ensuring the Economical and

Efficient Production of Voltaic Electricity for Lighting Streets and other Purposes." The object of the paper was to explain the means by which electricity could be readily and economically produced. The history of voltaic electricity was carefully traced from the time of Volta, from whom this form of electricity took its name, to the present time, special mention being made of Grove's, Smee's, the Maynooth, and other batteries which, from time to time, have been looked upon as vast improvements upon then existing apparatus. The theories of Mayer and Joule were referred to, as well as the researches of Professor Tyndall, whose "Heat as a Mode of Motion" contains so much valuable information upon the subject. He considered that the rapidity of the vibration of the atoms in a conductor was exactly in proportion to its conducting power, and explained that, whilst a battery was producing light and heat, less material was being consumed than when the battery poles are directly connected with each other. Mr. Dickson's battery was described as one of the hot-class—the sulphuric acid was heated to 600 degs. Fahr. He claims by his mode of applying heat to be able to use iron and other cheap metals, instead of the dear ones—zinc, copper, &c. The relative mobility of the atoms of an electrolite determined, he considered, its force rather than its specific gravity. When oil of vitriol was heated to 350 degs. Fahr. only, the electric action is less powerful than when heated to 600 degs. Fahr., probably owing to the waves being less rapid. With the necessary percolating apparatus he was convinced that his battery would be successful for light-house purposes. He considered 15 to 20 of his cells equal to 20 to 22 cells; 3 of his cells are not equal to 2 of the nitric acid cells, but the increment in his battery was greater. Grove's battery cost 1s. 5d. to produce the same amount of electricity as that produced for 10¼d. by Dickson's. Comparing the lighting powers, 11¼d. with the caloric battery will produce the same amount of light as 1s. 5d. by Grove's. He declared that the sulphur liberated at the negative poles could be reconverted into sulphuric acid to the extent of 19-20ths. The oil of vitriol, during the working of the battery, becomes combined with water, but the acid is easily and cheaply reconcentrated. In Smee's, Daniell's, and Grove's battery, the sulphate of zinc cannot be recovered, whilst in his caloric battery the recovery was not difficult.—The Chairman expressed the fear that the invention promised so much that he was no more likely to perform it than to obtain perpetual motion: indeed, if the invention were not overstated, they would certainly be nearer perpetual motion than they had ever been before. Mr. Varley suggested that as the principal feature in the invention appeared to be the heating of the materials, it was not impossible that it might be as great a step in advance as the introduction of the hot-blast in the manufacture of iron; this, of course, remained to be seen.—The new light has been exhibited, and an opportunity afforded for examining the caloric battery in operation.—*Mechanics' Magazine.*

ELECTRO-MAGNETIC ROTARY ENGINE.

The proposition to introduce electricity as a motive power has been revived in America; Captain John Reeves, of New York, having invented and patented an Electro-magnetic Rotary Engine, for producing motive-power by electricity to any extent, and for any purpose required. The inventor states that in his experiments "he has discovered, and is now prepared to verify the fact, that electricity can be diffused over surfaces to the extent of hundreds of superficial feet, and thereby cause an electro-magnetic attraction, which acts on and sets in motion the most powerful machinery for producing motive-power, and this at a most reasonable expense for material consumed." The inventor has a working model at the Capitol, Washington, with plans of different descriptions, which he has exhibited to the Government.

PHYSIOLOGICAL EFFECTS OF THE VACUUM APPARATUS.

Dr. Junot has read to the British Association a paper, showing the Physiological Effect of his Vacuum Apparatus, which has been extensively and successfully used in the treatment of disease. The principle is that of the air-pump, or of the cupping-glass. The instrument, which for the leg is a boot-shaped vessel, rendered air-tight, by a sleeve or cap of India-rubber, with a flexible tube connected with an exhausting syringe, has the effect of stimulating the vascular system to a high degree, and causing it to hold for a certain time a greatly increased quantity of blood. Experiments were made to show that this mode of treatment, although most powerful in its action, was entirely harmless on a healthy subject.

NO CURE FOR LOCK-JAW.

M. Matteucci has described to the French Academy of Sciences, a case of Lock-jaw, in which the patient was subjected to the action of a voltaic column of 30 or 40 couples. Under the influence of the electric currents the tetanic shocks diminished in intensity, and the patient could open and shut his mouth; but the relief was only temporary, and the contractions returned in spite of the action of the current, which was then discontinued for a short time, and resumed with a pile of about 60 elements. Again an improvement became manifest, and these alternations of relief and relapse continued for several hours; but the beneficial effects of the current gradually diminished, until they ceased altogether. M. Farini, who practised medicine at the time this experiment was made (1838), and who has since become celebrated as a statesman, told M. Matteucci that the disorder was occasioned by the existence of extraneous bodies in the patient's leg. M. Matteucci concludes with remarking that, since electricity produces relief of lock-jaw, which is almost the only result to be hoped for, the attention of practitioners should be called to it. — *Galignani's Messenger.*

BLASTING BY ELECTRICITY.

A correspondent of the *United States Railroad and Mining Register*, referring to the account of the new method of Blasting by Electricity, recently invented by a Frenchman, describes that arranged by the engineer corps of the Philadelphia and Reading Railroad Company, and used during the widening of the tunnels at Phœnixville and Manayunk, in the year 1859. The battery consisted of about 25 copper cells, 1 ft. long, by 11 in. deep, by 1 in. wide, open at top and bottom: these were set in a wooden frame, and separated from each other by common window-glass, which was also secured in the frame; inside of each of these cells was a plate of zinc, just large enough to allow a slip of grooved wood to hold it away from the copper at the ends. Each zinc plate was connected to the copper cell next to the one in which it was placed, making thus a very large voltaic pile. From each end of this battery an insulated wire ran to the holes to be fired, that from one extremity, of course, going from a copper, and the other from a zinc plate. The acid used was sulphuric, diluted in about thirty times its quantity of water. The frame was arranged to raise and lower into a wooden trough or bath, which contained the diluted acid, by a windlass, so that the person who was engaged in connecting the main wire to those in the holes did his work without any risk of an explosion, the battery not being lowered into the acid until he was at a safe distance. For firing the holes two wires were taken and twisted together. At first it was thought necessary that both should be insulated, but it was soon found that if one of them was coated with gutta-percha it was sufficient. At the end inserted into the holes these wires were separated about a quarter of an inch, and connected by a very thin piece of platinum wire; afterwards it was found that steel answered every purpose, and was much less expensive. This thin wire melted as the charge of electricity passed through it. At the commencement of the work this was inserted directly into the blasting-powder, but two great disadvantages arose therefrom—first, the danger of the small wire becoming broken in tamping the whole; and, second, the difficulty of igniting the coarse blasting-powder by the instantaneous spark of electricity; to avoid both of which a small paper bag, large enough to hold about a gun-shot charge, was placed over the end and filled with rifle-powder, the bottom being pasted, shut, and the top tied securely above the steel wire. Another difficulty then arose from the fact that, in handling the "cartridges," as they were called, the fine powder was frequently unavoidably shaken out of them. This the men who had charge of loading the holes soon discovered, and before inserting one, would finger the little paper bag to see if it

was full, and, as their hands were generally wet, injured the powder. To avoid this, gutta-percha was dissolved in ether, and the cartridge dipped into it; as soon as taken out of the mixture the volatile liquid evaporated, leaving a very thin coating of gutta-percha over the paper. Thus perfected, the "cartridge" was inserted into about the centre of the charge of blasting-powder in the hole, the opposite ends of the wires protruding; tamping was put in exactly as if fuze were used instead of wires. Before firing, a number of holes were connected together, by taking the protruding end of one wire of the first hole and twisting it to the end of one of the second, the remaining one of the second to one of the third, and so on. One of the main wires from the battery was then connected with the end of the first wire of this "batch," and the other to the end of the last; the battery was then immersed in the bath containing the acid, and the discharge of the whole lot was instantaneous and simultaneous. As many as twenty holes were frequently fired in one lot. The working of this arrangement was eminently successful. For three months an average of nearly 100 holes a day were fired at each tunnel without a single accident, so far as the blasting was concerned. This system is almost identical with the one invented in France. Many of the details, such as coating the bag with gutta-percha, &c., will be indicated by local circumstances to practical minds.

SUBMARINE TELEGRAPHY.

CAPTAIN SELWYN has read to the British Association a paper on "Submarine Telegraphy," in which he pointed out possible or probable causes of the failure and loss which have marked great enterprises of per-oceanic communication by means of electricity. Capt. Selwyn considers there is not the slightest doubt that gutta percha properly laid at the bottom of the sea, in whatever depth, is a perfect and reliable insulator of electricity. The compound of Mr. John Macintosh is, however, one half cheaper than either gutta percha or India-rubber, and nearly as much superior to either gum, whether in goodness of insulation, or lowness of inductive capacity. It has, too, the valuable property of being absolutely indestructible either in air or earth, as well as in water. The low price of this compound is due to the fact that it is mainly composed of paraffin; the cheapness, insulating properties, slowness of inductive capacity, need only to be generally known to secure its adoption.

The profits of a single Atlantic cable once laid, may be safely estimated at 600,000*l.* per annum, even on a very low speed of transmission; and it is certain that the feat once accomplished, many cables would be forthwith required to fulfil the demand for certain and rapid communication with the New World. With regard to the route, Capt. Selwyn states that recent discoveries of shoal water, 80 furlongs halfway, lat. 43 deg. 30 min. N., long. 38 deg. 50 min. W., in the direct great circle tract between this

country and the island of Bermuda, make it certain that means may be found of dividing any future cable into comparatively short sections; and while Capt. Selwyn repudiates the idea of anything like precipices at the bottom of the ocean, except in recently disturbed volcanic regions, there can be no doubt that more careful consideration of the currents and winds which sweep through and over the ocean will enable us to predict the existence of shoals at points. As regards the outer protection, which is in these cables, as hitherto made, a very large proportion of the whole, nothing can well be worse than the exposure of unprotected iron-wire to the certain decay from rust, which causes an item in one Company's balance-sheet of 8000*l.* a year for deterioration. I am of opinion that a species of vulcanized rubber-coating will be found the best and cheapest protecting material. With respect to the safe carrying and laying of the expensive and delicate telegraphic cable, a reel offers the most convenient and certain mode of handling a long wire or a long rope. But the enormous length here to be dealt with, the certainty that the weight must be enough to task the carrying of the largest known ships, led to the abandonment of the idea which did not fail, at first, to present itself—of putting the cable, when made, on a reel, which should be carried by a ship, and thence running it off into the ocean in the track of the carrying vessel.

Capt. Selwyn's experience, under Sir E. Belcher, of deep-sea soundings, led to the observation that a very rapid and easy method of letting a deep-sea line run itself off, is to be found by letting the reel itself afloat on the water; and many other small experiences of the behaviour of cylindrical floating bodies, either when towed or revolving, came in to assist the Captain in arriving at the decision which he has adopted, as best calculated to ensure success. This consists in the employment of one or more cylindrical drums, built of sheet-iron or wood, exactly as strongly put together as these materials now are in ships, with no more liability to leakage, but with the remarkable difference that here you have a ship or floating structure which is all hermetically sealed against the influx of water from any other cause. On these drums or floating cylinders, the whole cable to be laid is coiled; and owing to the great capacity or cubical contents of any cylindrical body, as much cable can be well and safely carried in this way for 5000*l.* as would cost, if in a ship, 30,000*l.*, or six times as much, without the safety.

Upwards of 10,000 miles of telegraph cables have been made and laid, and of this not one single cable, that has any title to the name of deep-sea, exists which has not been repaired; while most of those, which come under this denomination, have ceased to exist as means of communication. The majority of cables, which are talked of and written about as successes of eminent contractors, are either massive iron, which structures it was impossible to break, or they have been broken and raised for repairs; but all are undergoing a certain, and far from slow, process of decay,

which need never have been allowed, had the conditions of durability been apprehended and fulfilled as they might have been. But we ought not from these facts to argue that deep-sea cables are necessarily failures, or that any difficulty exists in making and laying them, which cannot be met, or will not be overcome, when public competition takes the sting from the "moral causes" of failure, which have so often been treated of as worse than the physical difficulties.

We may here add that the entire length of the Atlantic telegraph will be 2300 miles. There are seven copper wires to form the conductor, so that there are 16,000 miles of copper wire. Every portion of this wire is subjected to electrical tests to ascertain its quality for conduction before it is allowed to be worked up. The next stage is to coat these with eight successive coats of the insulating material, equal to an aggregate length of 18,400 miles. This core is next covered with jute wound round it from ten strands, making 23,000 miles of jute yarn. Then comes the outer coating formed of the ten covered iron wires. The iron wire itself is 23,000 miles in length, and each wire is covered separately with five strands of tarred hemp, 135,000 miles of the latter being required, making together an aggregate length of material employed of 215,000 miles.

INDIA-RUBBER-COVERED CABLES.

MESSRS. WELLS & HALL have delivered some few miles of India-rubber-covered Wire for Government telegraphs, a few particulars of which we append; because this length of core evinces a proficiency of workmanship of a very satisfactory and reassuring character, and augurs well for the future of submarine telegraphy, if the same care is exercised and perfection attained in the manufacture of the outward part of the cable, as is now attainable in what is technically termed the core.

The wire in question consists of a No. 18 (diam. ·043) tinned copper, insulated to a total diam. of ·25 in. Weight of copper per mile, 30 lb.; weight of insulator per mile, 60 lb. The resistance of the insulating medium for one mile, tested in water at a temperature of 60 deg. Fahr., is 4,750,000 Siemens' units, and the resistance of the conductor 54 Siemens' units. No tar is to be applied to the core, because of its well-known deteriorating effects when brought into contact with the rubber. The durability of this material is satisfactorily established if engineers will avoid the use of tar, and be more cautious that the protecting sheath shall not belie its character by introducing an element or elements of destruction. It will be obvious from this that the insulation tests, both static and dynamic, are of a very high character in comparison with results obtained on other materials.

A submarine cable has also been manufactured by Messrs. Siemens and Halske, at their cable-works, Woolwich, for the French Government. This cable is for the purpose of connecting Carthagena, in Spain, with Oran, in Algeria, and is 115 nautical miles long. The conductor consists of a strand of three annealed copper wires of the best conductivity, each ·038 of an inch in diameter, and weighing together 72 lb. per nautical mile. The resistance of the strand is measured by 18·5 Siemens' mercury units, at a temperature of 20 deg. C. The insulating covering consists of three alternate coatings of Chatterton's compound and the best gutta-percha, bringing the diameter of the core to ·26 of an inch. The weight of the insulating material is 144 lb. per nautical mile. The resistance of the insulating medium varies from 125 to 175 millions of Siemens' units at a temperature of 24 deg. C. without pressure, and from 300 to 400 millions under a pressure equal to 1400 fathoms of water. The outer covering is composed of two layers of the best hemp strings, dipped in a solution of sulphate of copper, and weighs 200 lb. per knot. It has been laid on under tension, and is encased in a flexible copper sheathing formed of four strips of phosphuretted best copper overlapping each other. The complete cable weighs 7½ cwt. per knot, and its breaking weight is 26 cwt. Its specific weight 1·9, and its diameter ·046 of an inch; and its length is 137 knots, as shipped on board the French Government vessel on the 15th of December, and, when tested there, gave the following results:—Resistance of conductor, 18·2 Siemens' units per knot; of insulating medium, 1300 units per knot at a temperature of 13 deg. C. —*Mechanics' Magazine.*

CHEAP TELEGRAPHY.

IN the *Mechanics' Magazine* is described an Electro-Magnetic Induction Machine, in which from three to six cells of a common Daniell's battery do what it takes all their long ranges of boxes of cells, tier above tier, to do. This is accomplished by an induction machine—not a Rhumkorf, not a monster coil like Whitehouse's, but a series of coils acting rhythmically together, giving a constant stream of large quantity and sufficient intensity, and which will not spark unless the wires from both poles be first brought in contact. The objects which the inventor of this machine proposed to himself are these:—1st. By means of magnetic induction to obtain from a few voltaic pairs a continuous stream of electricity in one direction, of any required tension. 2nd. The induced stream of electricity to be as manageable as that from the small exciting battery; and 3rd. The machine to be entirely self-acting. These objects are accomplished as follows:—1st. By associating two or more induction coils in such a manner that, when the magnetism in one coil or set of coils ceases, it shall be excited in the other, the resulting induced alternate currents in each coil or set of coils being caused to flow in one and the same direction. 2nd. These currents are brought under control by means of a four-port reversing commutator, whose diagonal ports are connected, so that by a simple oscillation its contacts are reversed just before

the reversal of the currents in each coil or set of coils. 3rd. The small exciting battery used with the machine not only excites the electro-magnets in the coil, but at the same time drives a rotatory break and oscillating commutator. The machine thus makes and breaks its own battery currents at the proper times, and also reverses its induced currents, and is thus perfectly self-acting.

By the aid of this machine a few cells of a battery become as powerful, either for telegraphic or for other purposes, as many cells in series, and the machine thus effects a most important saving both in first outlay and in subsequent cost of working, while it moreover requires less care and attention, and is at the same time much more certain in its action, than the ordinary batteries. The first machine of the kind made, though not large, is, however, much larger than will be required for ordinary telegraphic purposes. Where a battery of three or four dozen cells is at present used, a machine of this kind with one or two cells only will be sufficient to do all the work, so that single cells, by the aid of this machine, will be as serviceable as dozens are as now used. This ingenious invention—whatever may be thought of the Bonelli system in that respect—certainly constitutes a step forward in the direction of cheap telegraphy.

There is now in Liverpool, and in operation at the Electric Telegraph Company's Offices in Castle-street, an instrument which, from its ingenuity of construction and perfection of results, deserves most careful attention. The object is to transmit autograph messages in the exact form in which they are written; and the most complicated figures, designs, sketches, or indeed anything that can be drawn by an ordinary pen, are transmitted as readily as the simplest dot or stroke. The instrument may be described as consisting chiefly of an iron frame, resembling the letter A, within which a heavy pendulum vibrates. About half way up one side of the frame an axle is placed transversely, and connected by an arm below and a rod to the pendulum, so that every vibration of the pendulum rocks this axle to and fro for about one-third of a circle. On the upper side of the axle, and at each end of it an arm is affixed, carrying a bent pointer or tracer, which runs over and in contact with a brass plate, curved to suit the radius of the arm. The message or sketch to be transmitted having been written upon foil paper with an ordinary pen, it is placed upon one of these tables, a piece of prepared paper being similarly placed upon the distant instrument intended to receive the message, the pendulum is set in motion, and the pointer makes a traverse across the plate of foil upon which the message is written. At all the points of contact with the metal a current of electricity continues to pass through the instrument; but where the ink intervenes the current is broken, and a corresponding interruption takes place on the distant machine by means of a rack pinion and screw, all worked by the pendulum. The pointer traverses over the whole plate in twenty minutes, and in that time would transmit as many words as could be written upon half a sheet of letter paper. The smaller the writing, therefore, the better.

At the return stroke of the pendulum the pointer on the second table comes into operation: thus two messages are transmitted at the same time by alternate vibrations, and at the turn of each stroke the pendulum bob comes in contact with a magnet, which maintains its motion, and communicates a similar one to the distant pendulum, thus correcting the isochronism and ensuring coincidence in the figure transmitted.

The principle of transmitting written messages is not new; but former inventors used a barrel driven by clockwork as the table for the paper; and although perfect results similar to these could be obtained, the liability to error in the rate of two clocks, and the difficulty of getting an apparatus sufficiently delicate to repeat currents rapidly, has prevented their economical use.

The most beautiful parts of this instrument are the relay coils and the automatic connexions, which overcome these great difficulties so well, that the pointer may pass over a dozen or twenty words in a second, and the breaking and closing of the circuit will be complete for every letter. The influence of such improvements as these upon the commercial world is great, and may be judged from the fact that, in the London office of the Electric Telegraph Company alone, there are a dozen machines and operators for Liverpool work only.—*Railway News.*

There are now two systems of communicating telegrams on London lines in almost general use. The first is by the aid of a single needle, the Morse alphabet being in almost universal use. This enables a clerk, independent of his nationality or knowledge of language, to read off the letters from his instruments, so that an English clerk in London might send an English message to Russia, which would be read off by a Russian, and written in English. In like manner, an English girl would be able to read off a message sent in the Russian language, with the same ease that she could one in English. Thus there is a universal language in telegraphing as there is in music. The other method of communicating is by printing, the various letters being indicated by a series of dots and dashes. From the time of first commencing to study the instrument until proficiency is attained in reading and sending, two months usually elapse—shorter or longer, according to the talent of the clerk. A clerk is generally able to send a message before she can read one; it is also found much more easy to read the messages sent by one clerk than those by another. At the present time there are about 250 miles of wire, set up on the house-tops and underground, for the use of the London and twelve-miles-round telegraph; by the aid of these and the 83 stations now open, it would be possible to send about 1000 messages per hour—a quantity sufficient to render the district telegraph a very paying investment. At present, however, the average number per day, throughout the year, does not exceed 1000, so that only one-tenth of the work that might be done is actually accomplished.

Chemical Science.

RECENT PROGRESS OF CHEMICAL RESEARCH.

THE President of the Chemical Section of the British Association (Mr. Odling) commenced his opening address by remarking that, "After the great diversity, or rather antagonism, of opinion which has existed for the last dozen years or so, he was almost bound to take a somewhat prominent notice of one substantial agreement which now prevails among English chemists as to the combining proportions of the elementary bodies, and the molecular weights of their most important compounds. The present unanimity of opinion on this fundamental subject among those who have given it their attention is greater than has ever been the case since Dalton published his new system of Chemical Philosophy, more than half a century ago. As yet, indeed, the unanimity of practice falls considerably short of the unanimity of belief, but even in this direction great progress is being made, to which the publication of Miller's *Elements of Chemistry*, Watts's *Dictionary of Chemistry*, and Hoffman's *Jury Report on the Chemical Products in the Great Exhibition*, will doubtless give a yet stronger impetus. As was well observed by Dr. Miller at a previous meeting of this Association, 'Chemistry is not merely a science, it is also an art which has introduced its nomenclature and its notation into our manufactories, and in some measure even into our daily life; hence the great difficulty of effecting a speedy change in chemical usages alike so time-honoured and intimately ramified.'"

Mr. Odling then made certain remarks upon the history of this chemical reformation, of which we can only quote the portion dating from 1842, when Gerhardt announced his views upon the molecular constitution of water, previous to which there does not seem to have been any marked difference of opinion among chemists as to the combining proportions of the principal elements. With respect to the new system of atomic weights, Mr. Odling said :—

"Prior to the time of Gerhardt, the selection of Molecular Weights for different bodies, elementary and compound, had been almost a matter of hazard. Relying conjointly upon physical and chemical phenomena, he first established definite principles of selection, by pointing out the considerations upon which the determination of atomic weights must logically depend. Relying upon these principles, he established his classification of the non-metallic elements into monhydrides, represented by chlorine; dihydrides, represented by oxygen; terhydrides, represented by nitrogen, &c.; and relying upon the same principles, but with a greatly increased knowledge of phenomena, later chemists have given to his method a development and unity, more especially as regards the metallic elements, which have secured for the new system the impregnable and acknowledged position which it at present occupies. The comparative unanimity which prevailed before the time of Gerhardt was the unanimity of submission to authority, but the greater unanimity which now prevails is the unanimity of conviction consequent upon an intermediate period of solitary insurrection by general disturbance and ultimate triumph.

Bearing in mind how much the origin of the new system by Gerhardt, and its completion by his colleagues and disciples, are to a correct appreciation of the harmony subsisting between chemical and physical relations, we cannot but give a hearty welcome to any large exposition of mixed chemico-physical phenomena, and whether or not we agree with all his conclusions, there can be but one opinion as to the obligation chemists are under to Professor Kopp, of Giessen, for the great addition he has recently made to our knowledge, and means of obtaining a further knowledge of what has hitherto been but a very limited subject, namely, specific heat. The agreement of chemists as to the elemental atomic weights is tantamount to an agreement among them as to the relative quantities of the different kinds of matters which shall be represented by the different elemental symbols, and this brings me to the subject of Chemical Notation. At one time many chemists even of considerable eminence believed and taught that Gerhardt's reformation had reference mainly to notation, and not to the association and interpretation of phenomena, and it became rather a fashion among them to declaim against the puerilities of notational questions. That the idea is of far greater importance than the mode of expressing it is an obvious truism; but, nevertheless, the mode of expression has an importance of its own as facilitating the spread of the idea, and more especially its development and procreation. It has been well asked, in what position would the science of arithmetic have been but for the substitution of Arabic for Roman numerals—the notation in which value is expressed by the change in position for that in which it is expressed mainly by the repetition of a few simple signs?

"It is unfortunately too true that Chemical Notation is at present in anything but a satisfactory state. The much-used sign of addition is, I conceive, about the last one would deliberately select to represent the fine idea of chemical combination, which seems allied rather, I should say, to an interpenetration than to a coarse opposition of atoms. The placing of symbols in contiguity, or simply introducing a point between them, as indicative of a sort of multiplication or involution of the one atom into the other, is, I think, far preferable; but here, as pointed out by Sir John Herschel, we violate the ordinary algebraic understanding, which assigns very different numerical value to the expressions $x\,y$ and $x + y$ respectively. I know, indeed, that one among us has been engaged for some years past in conceiving and working out a new and strictly philosophical system of Chemical Notation by means of actual formulæ, instead of mere symbols: and I am sure that I only express the general wish of the Section when I ask Sir Benjamin Brodie not to postpone the publication of his views for a longer time than is absolutely necessary for their sufficient elaboration. In any case, however, the symbolic notation at present employed, with more or less modification of detail, must continue to have its peculiar uses as an instrument of interpretation, and it becomes therefore of importance to us to render it more precise in meaning and consistent in its application. Many of its incongruities belong to the very lowest order of convention; such, for example, as the custom of distinguishing between the representation of so-called mineral and organic compounds, one particular sequence of symbols being habitually employed in representing the compounds of carbon, and an entirely different sequence of symbols in representing the more or less analogous compounds of all other elements.

"Now that Organic and Mineral Chemistry are properly regarded as forming one continuous whole, a conclusion to which Colbe's researches on sulphuretted organic bodies have largely contributed, it is high time that such relics of the ancient superstition, that organic and mineral chemistry were essentially different from one another, should be done away with. Although during the past year, the direct advance of that crucial organic chemistry, the synthesis of natural organic bodies, has not been striking, yet, on the other hand, its indirect advance has, I submit, been very considerable. Several of the artificially produced organic compounds, at first thought to be identical with those of natural origin, have proved to be, as is well known, not identical, but only isomeric therewith. Hence, *reculer pour mieux sauter* chemists have been stepping back a little to examine more intimately the construction both of natural organic bodies and of their artificial isomers. The synthetic power having been allowed of putting the works together in almost any desired

way; it is yet necessary, in order to construct some particular biological product, to first learn the way in which its constituent bricks have been naturally put together. We accordingly find the study of Isomerism, or what comes to the same thing, the study of the intimate construction of bodies, is assuming an importance never before accorded to it. Isomerism is, in fact, the chemical problem of the day; and concurrently with its rapidly advancing solution, through the varied endeavours of many *workers*, will be the advance in rational organic synthesis. It is curious to note the oscillations of opinion in reference to this subject. Twenty years ago, the molecular constitution of bodies was perceived by a special instinct, simultaneously with, or even prior to, the establishment of their molecular weights. Then came an interval of scepticism, when the intimate constitution of bodies was maintained to be not only unknown, but unknowable. Now, we have a period of temperate reaction not recognising the desired knowledge as unallowable, but only as difficult of allowment. And in this, as in many other instances, we find evidence of the healthier state of mind in which now more perhaps than ever the first principles of chemical philosophy are explored. Speculation, indeed, is not less rife, and scarcely less esteemed than formerly; but it is now seldom or never mistaken for ascertained truth. Scepticism, indeed, still prevails; not, however, the barren scepticism of contentment, but the fertile scepticism which aspires to the greater and greater certainty of knowledge. Chemical science is advancing, I believe, not only more rapidly, but upon a surer basis than heretofore; and while, with every advance, the prospect widens before our eyes, so that we become almost alarmed at contemplating what those who come after us will have to learn, we console ourselves with the determination that their labour of unlearning shall be as little as possible—far less, we hope, than what we, in our time, have had to experience."

GUN-COTTON APPLIED TO WARLIKE PURPOSES.

THE General Committee of the British Association have resigned their duties to a Commission appointed by Government, with General Sabine as president; representing thus—the army, the navy, military and civil engineering, as well as chemical and physical science; and comprising three of the members of the Association Committee. The Government Committee is already engaged in a systematic course of experiments relating to the manufacture and keeping qualities of Gun-Cotton, and its use in artillery, small arms, and engineering. The Association Committee, therefore, consider that their work is accomplished, since the application of gun-cotton to military purposes is now in a fair way of being investigated with greater facilities and means than could have been at their disposal.

GUN-COTTON EXPLOSION.

DURING an inquest on the body of a person whose death had been caused by the explosion at Messrs. Prentice's gun-cotton factory, at Stowmarket, after several of the workpeople had been re-examined, Mr. Manning Prentice stated that he had visited various scientific gentlemen in London to endeavour to ascertain the cause of the explosion. Professor Tyndall, to whom the knife used in cutting the cotton, with its notches, was shown, at once expressed his opinion that it arose from this knife coming in contact with the copper wire employed in the cotton which is cut. Mr. Prentice also read a series of new regulations for the factory, prepared with the concurrence of Mr. Abel, the chemist to the War Department. Dr. William Allen Miller, Professor of Chemistry at King's College, London, the first scientific witness examined, said: "Dr. Frankland and myself came down from London on Saturday, and visited the Gun-Cotton Factory, where we saw the whole operation of the manufacture of the cotton. We then proceeded to make experiments on the ignition of gun-cotton by mechanical means, particularly with the cutting machine. We made a great number of experiments, our object being to satisfy ourselves upon the conditions which were likely to arise, and to ascertain the cause of the explosion. We took pieces of copper wire and placed them so that they should be cut through, and endeavoured to ignite it in that way. The copper was placed in various ways, sometimes spirally and sometimes in the rope, and we also tried to shave a piece off. We made 40 or 50 cuts through the rope and the copper in various ways, but did not succeed in firing the cotton in this manner. We put some small pieces of flint into the rope, and cut it three or four times without any explosion, but on the fourth or fifth cut the cotton exploded. I think there can be very little doubt that the explosion was caused by the action of the knife either upon copper or grit. I am not certain which, but I think most probably copper." The evidence of the scientific men was that the explosion was produced by the knife coming in contact with the copper wire or with a piece of grit; but they all inclined to the opinion that it was with the wire and not with the grit.

NEW EXPERIMENTS WITH GUN-COTTON.

THIS substance has again been the subject of interesting experiments, which we find described in a paper addressed to the French Academy of Sciences by M. de Luca. Gun-cotton is decomposed very slowly in the dark, somewhat faster in diffused light, very rapidly when exposed to the sun, and still more so when exposed to a heat of about 50 deg. Centigrade. This spontaneous decomposition passes through four different stages. At first, it contracts slowly without losing its primitive form and texture, so that its volume becomes ten times less than its original one. A few days later it becomes soft, and is transformed into a sort of gummy matter which adheres strongly to the fingers, and has no longer any appearance of texture or organization whatever, even when viewed through the microscope. When this mass has become quite homogeneous, its volume is again reduced by one-half. The third stage, which occurs some considerable time after, instead of producing any further contraction, causes an expansion, so that the substance, reduced as it is to one-nineteenth of its original volume, swells up to the full extent of the latter. In this state it is still gummy, but the mass is porous, and full of cavities like a sponge. During these three stages there is a constant evolution of nitrous vapours, which become much more abundant during the

third stage. This evolution of gas gradually diminishes during the fourth stage; the substance slowly loses its gummy quality and yellowish colour, and becomes so friable as to admit of being crushed into powder between one's fingers; it then becomes as white as sugar. It takes at least five months to see all these stages passed through. The sugary substance is very acid, nearly entirely soluble in water, and is composed of glucose, gummy substances, oxalic acid, a little formic acid, and another which M. de Luca thinks is new, and with which for the present he has obtained salts of lead and silver. The glucose contained in this last transformation of gun-cotton has the taste and even the flavour of honey; it quickly reduces the tartrate of copper and potash, and ferments in contact with yeast, producing carbonic acid and alcohol. It appears from M. de Luca's experiments that gun cotton will keep indefinitely in vacuo.—*Galignani's Messenger.*

THE THERMAL WATERS OF BATH.

Dr. Daubeny, in a paper communicated by him to the British Association, after briefly alluding to the mineral constitution of the Bath Waters, as affording no adequate explanation of the medicinal virtues ascribed to them, proceeded to one point of scientific interest connected with their appearance, namely: the large volume of gas which they have gone on continually disengaging, apparently from time immemorial. The nature and amount of this was made the subject of the author's examination in the year 1832, during an entire month; and the result arrived at was that the gas consisted mainly of nitrogen, which is present, indeed, in most thermal waters, but in none so copiously as at Bath. Judging from the circumstance that the majority of these springs are associated with volcanoes, and likewise that the same gas is freely evolved from the latter, both in an active and in a dormant condition, we may fairly infer that the evolution of nitrogen is in some way or other connected with the same widely-spread and deep-seated cause. And if this really be the case, the phenomenon in question acquires an additional interest, as affording a possible clue to the true nature of the processes which give rise to volcanoes as well as to thermal springs. Now, this evolution of nitrogen seems best to admit of explanation by supposing a process of combustion to be going on in the interior of the globe, by which oxygen may be abstracted from the common air which penetrates to these depths, whilst the residuary nitrogen is evolved. What may be the nature of the bodies by which this process of combustion is maintained must of course, from the depth at which the latter is carried on, be shrouded in mystery; but it is at least certain that, whilst they cannot belong to the category of those which supply the fuel for the ordinary processes of combustion of which we are eye-witnesses, there is nothing in the nature of the products resulting from volcanic action inconsistent with the idea that metals possessing a strong affinity for oxygen, but not already combined with it, might, if they existed in the interior of the earth, be instrumental in producing the supposed combustion. And if we indulge in speculation, we might maintain with some show of probability that the bases of the earths and alkalies which constitute the present crust of the globe, would have existed originally uncombined with oxygen, and therefore they must at one time have been subjected to that very process of oxidation and combustion which we imagine to be at the present time continued. The author therefore suggested that volcanic action may be owing to certain chemical re-actions proceeding in the interior of the earth, between the constituents of air and water on the one hand, and the metallic bases of the earths and alkalies on the other. After developing this theory, the paper concluded with pointing out a practical use to which the waste waters of the thermal springs of Bath might be applied; suggesting that if, instead of being discharged at once into the river, they were first conveyed through underground pipes a few feet beneath the surface, within a given area, the warmth imparted to the soil would prove highly favourable to the culture of tender exotics; and, moreover, if the ground were further protected from the cold by a glass roof, a winter garden might be obtained with scarcely any expense beyond that of the original outlay.

Mr. Vernon Harcourt has read to the British Association the following paper, which had been prepared by Professor Roscoe, F.R.S., of Manchester:—

"At the request of Sir Charles Lyell, I undertook the examination of the residue obtained by the evaporation of the Bath Waters (King's Bath spring) by spectrum analysis. About four ounces of the deposit from the basin in the pump-room was kindly forwarded to me by Dr. Falconer. This was first examined for strontium, barium, lithium, rubidium, and cæsium, by first boiling it out with water acidulated with hydrochloric acid; this separated the sulphate of calcium, of which the deposit mainly consists, together with most of the sulphates of strontium and barium which might be present. The residue was fused with carbonate of sodium, and the carbonates examined for barium and strontium, according to the method described by Bunsen. No trace of barium was found, but strontium was present in quantities sufficiently large to enable it to be easily detected. The portion of the deposit soluble in dilute hydrochloric acid was freed from alkaline earths by several precipitations with carbonate and oxalate of ammonia, and in this precipitate strontia was again detected. The magnesium was next separated by ignition of the mixed chlorides with oxide of mercury; and on examining the portions of the residue soluble in water, the red lithium line was plainly visible. The alkalies were precipitated as platinum double salts, but after long washing no other lines than those of potassium could be detected. It appeared, however, possible that the greater portion of the more soluble alkaline salts might not be spontaneously deposited from the water; I therefore requested Dr. Falconer to obtain some

residue from the evaporation of the whole water; but on examining, according to the above method, the salts thus derived from 20 gallons of water, I was still unable to detect the smallest traces of either rubidium or cæsium. In the course of both analyses I detected the presence of copper in the deposit by the usual tests. I have to thank Mr. Charles Moore for his kindness in forwarding a number of samples of various deposits from the Bath springs, some of which I have examined, but without discovering any other substance whose presence was previously unknown in the Bath waters."

Mr. Biggs said he was rather surprised that Professor Roscoe had omitted to mention the presence of all traces of manganese. He thought there was no doubt that it did exist. Dr. Paul also referred to the sources of nitrogen in the water.

MINERAL WATERS OF CENTRAL FRANCE.

M. Lecoq has communicated to the French Academy of Sciences his observations on the Mineral Waters existing in the centre of France, which never was covered by the sea, and presents the characteristics of a strong volcanic action. The number of mineral springs discovered by him amounts to 512, a number which he considers to be still incomplete. The majority of these springs are grouped together; large lines of fracture along the surface, chiefly lying north and south, mark series of mineral waters. Two of these lines follow the primitive steep declivities of the Limagne, and another skirts the sinuosities of the Allier. Most of the springs are rich in bicarbonate of lime and bicarbonate of soda.

MINERAL WATERS AND THEIR PROPERTIES

Have been recently investigated by M. Scoutetten, who has forwarded an account of his views to the French Academy of Sciences. This will be found in No. 13 of vol. lix. of the *Comptes Rendus*. He refers to chemical researches on the subject, but considers them insufficient to explain the phenomena of their action on the animal system. After giving details respecting the character and action of sea-water and other waters, he gives the following resumé of his opinions:—"1. Mineral waters determine all the phenomena of excitation due to electricity developed by contact with the body; 2. They determine a medicinal action, which varies according to the nature of the mineralising elements; and 3. They occasion a topical action, provoking divers eruptions on the skin." M. Scoutetten is very sanguine when he says—"Now that the mystery of mineral waters is revealed, medical applications of them may be made with the exactness and discernment indicated by science."

OXYGEN GAS EXPLOSION.

The use of Oxygen Gas was never more prevalent than at present. In the exhibition of the patent ghost of Messrs. Pepper and Dircks, it is an indispensable adjunct; and it has become a substitute, in almost all cases, for the coloured fires so long used for the production of supernatural effects at our theatres. Again, the oxy-hydrogen light, which depends for its extreme brilliancy upon oxygen, is extensively employed in the illustration of scientific lectures, and for the purposes of popular amusement. The coloured lights, it need not be said, are produced by the transmission of the rays of oxygen in combustion through heated lime and stained glass, and were first used by Professor Ansell, at the Panopticon, some years since. By the introduction of these and similar scientific improvements, oxygen has become almost a necessity; although its expansive and explosive properties make it as dangerous to deal with as high pressure steam or gunpowder, that is, in the hands of the tyro in chemistry.

In the elimination of oxygen, it is of the greatest importance that the closest attention should be paid to the evolvement of the gas; and, when ebullition ceases, that the heat which causes it should also cease to play upon the retort. These points were neglected entirely by a photographer at Manchester: hence the superheating and consequent expansion of the gas to the bursting strain, by which a retort placed on the fire in a kitchen, forming an improvised laboratory, exploded, and the photographer and his child were killed; and at Leeds, not long before this accident, two young women, who had been left by a *pseudo* chemist to watch a similar process, were killed on the spot by a like catastrophe. The oxygen most extensively used for the purposes named is eliminated from mixtures of chlorate of potassa and manganese, and all chemists are aware that the operation goes on with great rapidity. They accordingly provide apparatuses of sufficient strength to resist sudden pressure, and they are especially careful in apportioning the materials correctly. If too much manganese be employed, rapid fusion ensues; and the fused mass, driven by the evolving gas, quickly chokes the conducting tube, shuts up the safety-valve, as it were, and an explosion necessarily follows, as it would in a steam boiler under parallel circumstances. The proper proportions in which chlorate of potassa and manganese should be mixed are, a quarter of a pound of the former to a quarter of an ounce of the latter. The manganese really undergoes scarcely any chemical change, but acts principally by catalysis. This combination, if heated slowly over a gas flame, which, from the power we have of regulating its volume, is by far the best medium for effecting elimination, evolves oxygen gas, at first slowly, but soon with much rapidity; finally, the mass ignites, or rather glows into a red heat, and the oxygen is then given off with violence. These facts assuredly lead to the conclusion that under no circumstances should an ordinary fire be used for the elimination, or manufacture, as it is sometimes absurdly termed, of oxygen gas, from chlorate of potassa and manganese. It is safer to use glass vessels than those of any other material, because, if an explosion unfortunately

happens in spite of all precautions, the damage done to life and limb will then inevitably be comparatively small.

For eliminating oxygen on a small scale, a Florence oil-flask will answer as a retort exceedingly well; but, for extensive operations, an iron bottle, and the employment of black oxide of manganese as a catalysis, will be found advantageous and safe.—*Abridged from the Mechanics' Magazine.*

OXYGENATION.

At a lecture delivered to the shampooers and attendants at the Hammam, Jermyn-street, by Dr. Leared, Physician to the Hospital for Consumption, a novel mode of producing Oxygen Gas in a perfectly safe, cheap, and simple manner, was introduced for the first time in public by Mr. Robins, the analytical chemist. The method consists in treating chromate of potash and peroxide of barium with diluted sulphuric acid. The operation is performed in a common glass jar or retort, and at the ordinary temperature. To those who are acquainted with the plan hitherto adopted, of heating manganese in iron bottles, this discovery will need little recommendation, and it is difficult to predict to what discoveries and improvements in the economy of life and light it may lead. Meantime it is interesting that this discovery should have been first introduced to the public within the walls of an institution where the body is so largely benefited by natural processes of oxygenation.

OXYGENATED WATER.

Oxygenated Water (peroxide of hydrogen) is regarded as one of the most unstable of bodies; nevertheless (says M. Schönbein) it can be maintained at 100 deg. Cent. for several hours without being decomposed. If into boiling water, to which a little hydrochloric acid has been added, we put binoxide of barium to saturation, we shall find, in spite of the disengagement of oxygen, that a large quantity of oxygenated water has been formed. Oxygenated water is also formed by agitating boiling water, sharpened by 1 per cent. of sulphuric acid, with the amalgam of pasty lead, or with amalgam of zinc, or with shavings of cadmium. The same production takes place (says M. Schönbein) when we agitate boiling water containing 1 per cent. of potash, with a pyrogallic acid or hematoxyline.

NITROUS OXIDE (LAUGHING GAS) AS AN ANÆSTHETIC.

Professor Fleury has submitted to the Franklyn Institute, Philadelphia, a new apparatus for the cheap and speedy preparation of this Gas in great purity, the invention of M. F. Ruschhaupt, of Berlin. He stated that as this gas is itself a supporter of combustion and life, and does not produce any unpleasant effect when properly administered, much less cause loss of life, it must be far

preferable to the anæsthetics now in use—chloroform and ether, so frequently fatal. A detailed description of the apparatus is given in the *Journal of the Franklyn Institute.*

CARBONIC ACID FROM THE INTERIOR OF THE EARTH.

Dr. Daubeny has read to the British Association a paper, "On the Cause of the Extraction of Carbonic Acid from the Interior of the Earth, and its Chemical Action upon the Constituents of Felspathic Rocks." The author commented upon a theory advanced by Professor Bischoff, of Bonn, in his *Elements of Chemical and Physical Geology*, in which the elevation and dislocation of certain rocks were attributed to the decomposition of felspar, through the agency of the carbonic acid disengaged from the interior of the earth; seeing that the products of the decomposition of granite are found to possess a lower specific gravity, and therefore occupy more space than the original materials of the rock. Such a change would, doubtless, occur in granite, if acted upon by carbonic acid, at a temperature below 212°; but at over that point the very opposite would be observed, inasmuch as the silica would then take the place of the carbonic acid, and consequently if brought into contact with earthy or alkaline carbonates in the interior of the earth, would produce silicates and expel carbonic acid, as, indeed, was long ago pointed out by the author of this paper in his work on Volcanoes, and is insisted upon by Professor Bischoff himself, in other parts of his volume. It seems difficult, therefore, to attach much importance to the cause assigned by Professor Bischoff for the elevation of strata, especially considering that the loss of substance incurred by the rock through the removal of its alkali by the agency of carbonic acid, would go far towards counterbalancing any expansion due to the lower specific gravity of the kaolin resulting; and, moreover, recollecting that no theory which professes to account for the elevation of certain portions of the earth's surface ought to be accepted, if it does not embrace likewise the corresponding phenomenon of the sinking or depression of others.

THE DECOMPOSITION OF CARBONIC ACID GAS

By the Leaves of Plants is the subject of a note by M. Cloëz, laid before the French Academy of Sciences. Numerous experiments have proved that plants possessed of leaves and under the influence of light, assimilate carbon by the reduction of carbonic acid, giving cause to the disengagement of oxygen. The parts of the plants exposed to light have various colours. Of these, green is predominant, being the normal colour of the larger plant, and, as M. Cloëz asserts, should be considered as essential to the parts which decompose carbonic acid. M. Cloëz maintains, in opposition to the opinion of MM. Saussure and Corenwinder, that certain parts of the plant—such as the brown, yellow, and purple

leaves—although apparently deprived of green, still retain it partially, and that it is by virtue of this part alone, that they decompose carbonic acid. In No. 20 of vol. lvii. of the *Comptes Rendus*, will be found details of experiments which lead M. Cloëz to affirm that leaves decompose carbonic acid under the influence of light by reason of the green matter which they contain, and that the yellow and red parts do not give rise to this decomposition.

RESPIRATION OF FRUITS.

THE eminent chemist, M. Cahours, has recently reported to the French Academy of Sciences some of the results of his researches on this subject. Since the investigations of De Saussure the respiration of vegetables has been examined by Boussingault in regard to the emission of nitrogen during the decomposition of carbonic acid by the leaves, and by MM. Cloëz and Gratiolet in relation to the vegetation of submerged plants. M. Cahours thinks that these researches ought not to be limited to the green and coloured parts of plants, but should be extended to the organs of every function, and that the gaseous productions of these organs should be especially studied; and, with this view, he has especially directed his attention to the fruit. We give the chief points of his paper:—The grain which occupies the centre when it is confided to the earth developes itself according to known laws. The parenchyme which wholly envelopes it, is preserved in growing as long as it can protect it, and is afterwards removed by fermentation when useless. All fruit, then, beside during the period of its maturation (the chemical phenomena of which have been so well described by Decaisne and Fremy), has a period when it is preserved by respiration. M. Cahours's experiments were directed to the study of—1. The proportion of the gases contained in the parenchyme of the pericarp, and their composition. 2. The action of the fruit on the gas of respiration (oxygen), either alone or mixed with nitrogen; and, 3. The action of the same gas on each of the envelopes of the fruit, and its fleshy part where it exists. By following this method, he became assured that apples, oranges, and lemons, in the state of perfect maturity, when placed under bell-glasses containing either pure oxygen, mixtures of nitrogen and oxygen, or, finally, atmospheric air, respire by consuming a certain quantity of oxygen and giving off a sensible quantity of carbonic acid, the proportion of the last being always more considerable in diffused light than in obscurity. It takes place gradually, until a certain epoch, after which it considerably augments, and the internal face of the skin touching the fruit presents then a certain alteration. For the details of M. Cahours's method of experimenting we must refer to the *Comptes Rendus*, vol. lviii., No. 11. M. Cahours proposes to continue his studies, directing his attention to the gases contained in the juices of different species of fruits from the time of development to their maturity.—*Illustrated London News.*

CARBONIC ACID IN THE AIR OF MANCHESTER.

PROFESSOR ROSCOE gives the results of a recent examination reported in the *Chemical News*, which show that "the maximum quantity of carbonic acid gas contained in Manchester air, even in a dense fog, and when there is no wind, does not exceed 6 volumes per 10,000 of air; whilst the mean quantity, 3·9 volumes, closely agrees with that (4·0) generally assumed, from Saussure's early experiments, to represent the average composition of the atmosphere as regards carbonic acid. Hence we may conclude that the combustion of coal and the respiration of animals exert no appreciable influence on the quantity of carbonic acid contained in the town air of Manchester collected in an open situation; gaseous diffusion and the great motions of the atmosphere serving completely to disperse the millions of tons of this gas which every year are evolved by the above-mentioned causes in this neighbourhood."

THE CHANGES IN DISCHARGED FIREARMS

Have been recently investigated by Dr. Decker, who states that, whatever may be the construction of the weapon, after its discharge there is produced in its exterior and interior a modification in its physical and chemical characters varying with the progress of time. Immediately after the discharge there is formed in the interior and exterior of the gun a blackish blue deposit, the age of which may be estimated by the variations in its composition. The red spots of the gun proceed from the action of the residue of the charge on the metal; for an arm that has not been used does not rust in a moist atmosphere in the same manner as one that has been used. Variations in the quality of the powder and in the construction of the gun do not exercise any influence over the chemical character of the deposit resulting from the combustion of the powder. M. Decker states that he is proceeding in his researches, with especial relation to copper cannon and to gun-cotton. Thus chemical science can detect whether a gun has been fired or not; and, to a certain extent, how long it has been so used.

ADMINISTRATION OF CHLOROFORM.

A PROFESSIONAL Correspondent of the *Times* suggests the propriety of inquiring why the fatal effects of Chloroform should be so frequent, after it has been well ascertained that they may be easily prevented. During the sixteen years which have elapsed since the use of chloroform was adopted in the practice of surgery, the writer has employed it in a large hospital and in private almost daily, and very often repeatedly on the same day; so that the cases which have fallen under his observation cannot be fewer than 5000 or 6000, yet he never met with one that proved fatal. The writer continues—

"In explanation of this satisfactory result, it may be supposed that I have been very careful in the discrimination of cases, and the rejection of those presenting a suspicious character, while, on the contrary, I have never made any inquiry into the patient's condition, or even been deterred by the information obtained otherwise that his heart was suffering from serious organic disease.

"It may, then, be supposed that I possess some curiously contrived apparatus for regulating the process so as to insure safety, while I have never employed any other means for the purpose than a thick towel, held loosely over the patient's face. Lastly, it may be supposed that I have had the assistance of a skilful administrator, whose care and experience enabled him to steer clear of danger; while I have always trusted to the hospital students, who, without any special training, simply followed the steps of those preceding them.

"The truth is, that the fatal effects of chloroform depend not upon peculiarities of individual constitution, but upon faults in the mode and management of administration.

"In conclusion, I beg to say that all the mischief in question has proceeded from the three following causes:

"First, taking the circulation instead of the respiration as a guide in watching the effect produced, and feeling the pulse instead of listening to the breath; secondly, using some apparatus which does not afford the perfect security of a large dilution with atmospheric air that is obtained from the simple means above mentioned; thirdly, want of attention to the fact that the tongue, from falling back into the throat, is apt to impede respiration, or obstruct it altogether, although, from heaving of the chest, it still appears to be performed. If this be recognised and immediately remedied by forcibly pulling the tongue forwards, the patient makes a deep, sonorous inspiration, and is safe; but if, unfortunately, it is not noticed, and the essential means of relief are withheld, all the galvanic batteries, brandy, and contrivances for artificial respiration which are summoned in frantic haste, will prove insufficient to restore animation."

TESTING GAS.

PROFESSOR W. B. ROGERS has read to the British Association "An Account of Apparatus and Processes for the Chemical and Photometrical Testing of Illuminating Gas." The instruments and methods described in this communication are those adopted in the gas inspection lately organized by Professor Rogers for the State of Massachusetts; comprising the measurement as well as testing of gas. Connected with the former of these objects, an account was given of the adjustments of the standard measure for gauging gasholders—of a universal clamp for meter-connexions—and of an appendage combining a delicate thermometer and pressure-gauge for the inlet and outlet of the meter, and by which the

rate of delivery is accurately adjusted. For chemical testing, the eudiometer, consisting of a graduated tube, with cylindrical enlargement, is permanently inclosed in a wider tube full of water, which maintains the temperature nearly uniform. The mouth of the graduated tube is furnished with a hollow ground stopper, for holding the several liquid absorbents used in the successive experiments. With this apparatus it is easy to determine the per-centage of carbonic acid, of illuminating hydrocarbons, of oxygen, and of carbonic oxide; after which the hydrogen and light carburetted hydrogen are ascertained by explosion, by means of an instrument consisting mainly of two glass tubes, united below by a long loop of rubber-tube, being a modification of Frankland's apparatus. For determining the sulphur, an improved arrangement is used, in which the stream of water supplying the Liebig's condenser is made to convey a stream of air, mingled with ammonia, into the condensing tube some inches above the flame of the burning gas. To secure a larger and more constant unit of illumination than the candle commonly used, a lamp burning kerasine, with a flat wick, is employed, in which, by means of a bridge of platinum wire, the flame may be maintained of constant size, and giving a light equal to about seven candles. This is supported on a balance of peculiar construction, giving the consumption during the experiment. Professor Rogers has found that even the small amount of carbonic acid which in some gas works is allowed to remain in the gas, produces a sensible reduction of the light. This effect, varying with the strength of the illuminating gas, was found to range from 3 to nearly 5 per cent. of the illuminating power for each per cent. of the impurity; 58 per cent. of carbonic acid, although it did not prevent combustion, made the flame so dim as to be without effect on the photometer.

MEASUREMENT OF GAS.

MR. GLOVER has read to the British Association a paper on the Measurement of Gas; in which, after detailing the instruments hitherto employed, and their imperfections, he states that eventually a plan was employed which was found free from the same liability to error. Instead of using the cubic foot bottle indirectly through the intervention of a second vessel, as had hitherto been done, the second vessel was dispensed with, and the bottle was used directly. Close the opening caused by the withdrawal of the plug with glass; solder a piece of leaden tube to the end of the tap; connect this tube with the gas-holder to be tested; place a cistern below the bottle which has been secured in a fixed position; raise the cistern steadily, without agitation of the water, through the entire length of the bottle until the water reaches the point where the plug of the tap, had it been retained, would have stopped it—the entire volume of air, viz., one cubic foot defined by the contents of the bottle, will be found to have been transferred

to the gas-holder. Tested by numerous experiments, the results of this method have been invariably satisfactory, and it has removed a difficulty long felt by meter-makers in the graduation of their holders for testing meters. To reduce to practice the idea of a machine for the accurate measurement and correct registration of gas, the experience of half a century has shown to be no easy problem. The construction of a good and durable dry gas-meter involves a multiplicity of mechanical and chemical considerations, to each of which its due weight must be assigned. A subtle invisible elastic and complex fluid, susceptible of change in condition and volume from very slight variations of temperature and pressure, has to be accurately measured, and the result must be correctly recorded. The instrument is self-acting. It must do its work in a closed chamber, continuously or at intervals, and free from all interference. The parts of the instrument which come in contact with gas must be made of anti-corrosive material. And the material forms and combinations of its different parts must be so accurately adapted as to produce steadiness, uniformity, and correctness in its movements. Whilst gas, having become a staple commodity, one of the necessaries of life, that it may have a real practical value, the instrument for its measurement must be produced at a price which will place it within the reach of every class. Realising these essential conditions, and approaching as near as may be to the accuracy of the standards, the dry gas-meter has taken the place to which it is entitled, as a valuable addition to many ingenious and useful contrivances of mechanical science.

SODA IN COAL GAS.

We learn from the *Chemical News*, that while examining, by the spectrum apparatus, the flame of the gas supplied in Munich, Professor Vogel noticed a pale Soda line which was not observed when the Gas was passed through sulphuric acid. On examining afterwards the surface of a copper burner which had been in use for a year, he detected a considerable proportion of sulphate of soda.

RESEARCHES ON OZONE.

The year 1864 has been unusually productive of contributions to the history of the economy of Ozone.

A new continuous source of Ozone has been announced by M. R. Bœttger. He combines in a capsule of porcelain, at ordinary temperature, by means of a glass rod, two parts troy-weight of perfectly dry permanganate of potash with three parts of hydrated sulphuric acid. When this mixture is introduced into a large flask with a glass stopper, ozone is continuously produced through the decomposition of the permanganate of potash.

The influence of Ozone on Vegetation has been studied by Mr. Carey Lea, of Philadelphia, and the results reported in the *American Journal of Science*:—

Two sets of experiments were made. In the first, the water with which the seeds came in contact was made to contain those solid substances which are most essential to vegetation. In the second, very pure river-water was used. For the first, phosphate of soda, silicate of potash, sulphate of magnesia, nitrate of lime, and sesquichloride of iron were added to water in a proportion such as to be equivalent to three-tenths of one per cent. of solid matter. In order to afford a just term of comparison, two vessels every way similar were filled with this prepared water, were covered with gauze so that the gauze should rest on the surface of the water, and were placed under bell-glasses resting on glass plates. Wheat and maize grains were placed on this gauze, and beneath one bell-glass was introduced the Ozone-generating mixture. On the twelfth day the experiment was terminated. The average height of the wheat plants not exposed to the Ozone was ten inches, of those exposed four inches. The effect of the ozone in checking the growth of the roots was very remarkable, especially with the wheat plants. In those not exposed to Ozone the roots attained a length equal to about one-fourth the height of the stem. In those exposed to it the roots, after starting, almost immediately ceased to grow. The strongest plant attained a height of six inches, and developed six rootlets, averaging only three-sixteenths of an inch in length; while those not exposed to Ozone had many roots exceeding two inches and a half. As a whole, the roots produced by the plants under the influence of ozone did not exceed one-tenth of those produced in its absence from an equal number of healthy seeds. One curious result of the almost total absence of roots was that the wheat-plants were scarcely able to sustain themselves in a vertical position; the greater part of them fell over on one side. The flatness of the grains of the maize afforded these plants a better support. The presence of ozone also prevented the usual formation of mould on seeds placed in contact with air and water under a bell-glass.

Dr. Allnatt gives the result of his experience in regard to the best preparations for Testing Ozone. He demurs to the opinion of Schönbein and Scoutetten, that it is immaterial what medium is employed. He says that if common writing-paper be used, or, what is equally objectionable, medium white cartridge-paper, the tests invariably discolour in irregular patches, blot in distinct isolated dots, or form minute cuneiform characters, and when damped present a non-uniform surface. He concludes, that bibulous paper, saturated with a solution of iodide of potassium and starch, or thin arrowroot, affords the most effective test we possess. The formula of its preparation is as follows:—"Take of pure white starch, one ounce; iodide of potassium, three drachms; mix in a marble mortar, and add gradually six ounces of boiling water. The papers are to be saturated with the mixture while hot, carefully dried out of contact with the external air, and preserved in close tin boxes."

On August 4, Dr. Allnatt writes: In his last Quarterly Report the city officer of health, Dr. Letheby, states "that the temperature has been low, or the small amount of fresh water in the Thames would have been productive of the putrefactive changes which characterized the spring quarters of 1858 and 1859."

Another important element may be admitted into the calculation. It is known that Ozone, one of the constituents of the atmosphere —or rather, perhaps, one of its variable concomitants—is the greatest natural disinfecting agent existing. It seizes upon pestilential miasmata, and by an instantaneous combination destroys their noxious qualities. During the spring quarter of the year 1864, the generation of Ozone was unusually large, especially

throughout the intense heat of May, and the mean of that month reached 9·02 deg.; the *maximum*, 10 deg., having been attained on seventeen days, and the *minimum*, or 6 deg., having been registered on two days only.

Again, during the dog-days, the prevailing north-east winds, clouded skies, and persistent manifestation of Ozone, mercifully tended to purify the atmosphere, and modify the prevailing type of zymotic diseases.

Mr. Lowe, who has for several years investigated the subject, says: Assuming that we have adopted the best tests and the most approved method of using those tests, before the actual amount of Ozone can be registered, it will be requisite to correct the readings for the velocity of air at the time for the height of the barometer, for temperature, and for the hygrometrical condition of the atmosphere. It must be borne in mind that if in a given time 1000 cubic feet of air passing through the ozone-box gives a register of 4, 2000 feet passing through in the same time will give one of double that amount. Moisture can also increase or diminish the action, a very dry air, or a perfectly saturated atmosphere showing a *minimum*.

The lower the barometer descends the more Ozone is shown upon the tests. Yet this is in part due to the increased velocity of the air which usually occurs at the same time. In very hot or very cold weather Ozone is also at a *minimum*. With a west there is much more ozone than with an east wind.

The *maximum* amount of Ozone will occur with a moderately moist atmosphere, a temperature between 50 deg. and 60 deg., a barometrical pressure under 29 inches, and a gale occurring at the same time.

Before the actual amount of Ozone can be ascertained, certain corrections must be applied, and until uniformity is adopted the observations cannot be made comparable. Under these circumstances we can do little more than record much or little Ozone.

With reference to the discussion on the amount of Ozone, a member of the Meteorological Society expresses the opinion that until some better means are found of measuring it, the observations on the subject are of very little value. Some time ago the writer exposed six slips of Ozone paper, obtained from eminent makers (Negretti and Zambra), side by side, under exactly similar circumstances, and for the same time. The result was that no two gave the same indications, nor, in fact, any one through its whole length. Every number on the scale from 2 to 10 was represented.

STUDY OF METALLURGY.

Professor Tennant has made to the British Association some noteworthy remarks upon the little actually known of Metallurgy by those employed in its operations. Of the exact number of minerals found in this country, but few persons are able to describe

more than fifty. Emigrants holding important situations in our colonies, know nothing of the metals found there. In 1850, it was asserted that gold existed to a great extent in Australia, but it was denied. The first piece discovered, and sent to this country, weighed 9½ oz. The timid feared it would reduce the value of gold to 7s. 6d. per pound. Next year, the amount of gold received was 150 tons, and in fifteen years it had amounted to 1500 tons received from Australia; yet the value of gold has not been affected. In the district where the gold was found, was also found a black substance, which was ignorantly thrown away: this proved to be oxide of tin, and was sold for 40*l.* At the present time, we have in this country 300,000 persons employed in mining operations; but in all our schools devoted to Mineralogy and Geology, we have not 300 persons; while no country in the world affords such excellent opportunities of studying these subjects as do the British Isles.

COPPER-SMELTING.

Mr. Spence, in a paper read by him to the British Association, "On Copper-smelting, and the means of Economising the Sulphur evolved in the Operations," said, he had for some years aimed at erecting works on sound chemical principles. With his first furnace he calcined the small ores, with a small expenditure of fuel and labour, with elimination of all the sulphur from the ores, if required; and it enabled him to send all the sulphur so eliminated into the vitriol chambers, or sulphureous acid gas. He soon erected additional furnaces; and all the sulphuric acid made at his works since the end of 1861 had been made from these small ores by similar furnaces. The amount of sulphur wasted in copper-smelting, and which could be economised for the use of such furnaces as he had erected, had been estimated at 70,000 tons per annum, now worth 455,000*l.*

OUR MINERAL WEALTH.

Through the courtesy of our esteemed correspondent, Mr. Robert Hunt, F.R.S., the Keeper of Mining Records at the Royal School of Mines, we have been favoured with the statistics of our mineral production for 1863. The value of the minerals produced was 29,151,976*l.*, from which metals of the value of 36,364,327*l.* were extracted. Of gold quartz we produced 385 tons, worth 1500*l.*; of tin ore, 15,157 tons, worth 963,985*l.*; of copper ore, 212,947 tons, worth 1,100,554*l.*; of lead ore, 91,283 tons, worth 1,193,530*l.*; of silver ore, 88 tons, worth 5703*l.*; and of zinc ore, 12,941 tons, worth 29,968*l.* During the year in question there were sold 95,376 tons of pyrites for 62,035*l.*; and the rarer minerals—wolfram, uranium, gossans, arsenic, and earthy minerals raised, were of the value of 1,980,866*l.* These items, with the value of 9,101,552 tons of iron ore, 3,240,890*l.*,

and 86,292,215 tons of coal, 20,572,945*l.*, raises the total to 29,151,976*l.*, which was manufactured into nearly 40,000,000*l.* of merchantable produce. To produce these results, direct employment has been given to at least 500,000 men, so that our mineral industries may be considered as alone supporting a population of nearly 3,000,000, in addition to adding much to the general wealth of the kingdom, and especially to the wealth of those whose capital has been employed in mining operations.—*Mining Journal.*

NEW METHOD OF EXTRACTING GOLD.

Mr. Briggs has read to the British Association a paper from Mr. T. C. Calvert, of Manchester, on "A New Method of Extracting Gold from Auriferous Ores." Mr. Calvert says: "Being convinced that nascent chloride was a fit and proper agent for cheaply extracting gold from ores, and that it was probably only necessary to modify the method of operating, I allowed the mixture of hydrochloric acid and peroxide of manganese, or of sulphuric acid, peroxide of manganese and chloride of sodium, to remain for twelve hours in contact with the auriferous sand; and then, instead of washing out the solution of gold, I added a small quantity of water, which removed a part of the acting agent, and this was made to percolate several times through the sand; by which method I succeeded in extracting from the sand, within a fraction, the whole of the gold. I then repeated the last experiments with natural auriferous quartz, and easily extracted the two ounces of gold per ton which it contained. I therefore propose the following plan for extracting the gold on a commercial scale:—

"The finely-reduced auriferous quartz should be intimately mixed with about one per cent. of peroxide of manganese; and if common salt be used, this material should be added at the same time as the manganese, in the proportion of three parts of salt to two of manganese. The whole should be then introduced into closed vats, having false bottoms, upon which is laid a quantity of small branches covered with straw, so as to prevent the reduced quartz from filling the holes in the false bottom. Muriatic acid should then be added if manganese alone is used, and diluted sulphuric acid if manganese and salt have been employed, and, after having left the whole in contact for 12 hours, water should be added so as to fill up the whole space between the false and true bottoms with fluid. This fluid should then be pumped up and allowed to percolate through the mass, and after this has been done several times, the fluid should be run off into separate vats for extracting the gold and copper that it may contain. To effect this, old iron is placed in it to precipitate the copper; and after this has been removed, the liquor is heated to drive away the excess of free chlorine, and a concentrated solution of sulphate of protoxide of iron, or green copperas, must be added, which, acting on the gold solution, will precipitate the gold in a metallic form. By this method both gold and copper are obtained in a marketable condition. If silver is present in the ore, a slight modification in the process will enable the operator to obtain this metal also. It is simply necessary to generate the chlorine of the vitriol, manganese, and chloride of sodium process, taking care to use an excess of salt, that is, six parts instead of three, as above directed. The purpose of this chloride of sodium being to hold in solution any chloride of silver that may have been formed by the action of chlorine on the silver ore, and to extract the metal, the following alteration in the mode of precipitation is necessary. Blades of copper must be placed in the metallic solutions, to throw down the silver in a metallic form, then blades of iron to throw down the copper, the gold being then extracted, as previously directed.

"I think the advantages of this process are, 1st, cheapness; 2nd, absence of injury to the health of the persons employed; 3rd, that not only is the metallic gold in the ore extracted (as is done by mercury), but it attacks and dissolves all gold which may be present in a combined state, besides enabling the miner also to extract what silver and copper the ore may contain. I cannot, however, conclude without reminding you of what is generally underrated—that is, the heavy expenses which attend the bringing of the ore to the surface of the ground, and crushing and preparing it for being acted upon either by mercury or by any other agents."

ALLOYS OF SILVER.

Some new Alloys have been reported to the French Academy of Sciences by M. Peligot—1. Alloys in which copper is replaced by zinc. 2. Alloys in which a part of the copper only is replaced by zinc; and, 3. Atomic alloys formed by zinc and silver—all produced under the same conditions. The alloys in which copper has been replaced by zinc possess remarkable malleability, and all possess a particularly homogeneous structure which will enable them to be used under the same circumstances as alloys of copper and silver. They possess a fine white colour. Where the zinc alone is associated with silver the tint of the alloy is somewhat yellowish, but the association of zinc with the copper tends to furnish whiter products.

NEW SOURCES OF THALLIUM.

Professor W. L. Scott has read to the British Association a paper in which he describes his obtaining this new metal from sands from Alum Bay. The general plan adopted was to precipitate the mixed metals as sulphides, after fusing the sands with caustic or carbonates of the alkalies, or in the usual way; then to redissolve the precipitate in acid, add acetate of sodium and tartaric acid to retain the iron, and finally throw down the Thallium present as oxide by potassa. On reduction, the thallium was obtained in a state of purity sufficient for all ordinary purposes. Simple digestion of the sands with hydrochloric acid, to which 10 per cent. of water and 5 per cent. of nitric acid have been added, at a temperature of 180 deg. Fahr., will suffice for the extraction of a variable portion of the thallium; but the entire quantity present can never be obtained by such means, according to Prof. Scott's experiments. Frequently, however, if Alum Bay sands, or certain other varieties of the same, such as Prof. Scott's specimens, are moistened with acid slightly diluted, heated in a water-bath for an hour or two, and then exposed to the action of a weak voltaic current for some days, employing platinum electrode of large surface, the thallium will be deposited in the metallic

state (mixed with a little oxide here and there), and can be easily dissolved off the platinum plate, which it has enfilmed; either by an acid, in which case the processes of reprecipitation and reduction must be gone through in order to obtain the metal; or by mercury, when the amalgam thus produced may be heated to volatilize the fluid metal, and separate the thallium, which, of course, remains in the containing vessel. The question now arises, do all the sands of Alum Bay, which, as it should be mentioned, differ among themselves in almost every physical aspect, colour, structure, specific gravity, and state of division (or degree of fineness), being unlike in every two separate specimens—do they all contain thallium? and in what proportion? To the first query Prof. Scott returns an emphatic negative; and to the second, the somewhat unsatisfactory reply, "in all proportions, from nearly a half per cent. downwards." In taking the term "Alum Bay Sand," it is not intended to designate the shore-sand situated beyond the line of shingles, and only exposed to view at low-water, but the rock sands of which, in great part, the lofty, perpendicular cliffs are composed at the south-eastern portion of the bay, and whose many-coloured patches and striæ offer such striking points of interest to the spectator. As a rule, the seashore sand contains no thallium, or at most presents but rare and feeble indications of the metal, and a similar observation also applies to the greater part of the more ordinary-looking sand, even of the cliffs above. It is only in examining the less common, and more highly-tinted varieties, that thallium is discovered. Many varieties of Alum Bay sand contain thallium in no inconsiderable proportion; and the veins of striæ of a grey-violet tint, and the delicate pink-coloured sand, Prof. Scott found richest in the metal. A block of violet sand yielded upwards of 0·4 per cent. of thallium; beautiful red sand, 0·327. The yellow sand is far more common than either of the preceding kinds, but it seldom yields much thallium, and often none. Many of the deeply-coloured clays which, in several places, alternate with the sands at Alum Bay, also give indications, more or less marked, of containing thallium, which has even been occasionally detected in the brown ligneous matter called "Isle of Wight coal."

With regard to the particular state of combination in which thallium exists when present in any of these sands, Prof. Scott does not give any definite information: he is of opinion that it is there in more than one form.

In analysing the mineral waters of Nauheim, M. Bœttger found them to contain principally chlorides of magnesium and potassium, accompanied by a certain quantity of chloride of sodium and traces of the three new metals rubidium, cæsium, and thallium. On adding to a solution of the salts extracted from the mother-liquor a quantity of chloride of platinum insufficient to precipitate all the chlorides, a powder of a clear yellow colour was obtained, which, after having been boiled three or four times in distilled water, gave in the spectrum apparatus, together with the rays of rubidium and

cæsium, those which characterise thallium. In consequence, M. Bœttger thinks that thallium ought to be ranged with the alkaline metals in chemical classification.—*Répertoire de Chimie.*

Mr. Crookes, the discoverer of thallium, has proved that the metal may often be found in the muriatic or hydrochloric acid of commerce. (See also "Thallium known to the ancient Mexicans," p. 140, *ante.*)

VANADIUM

Is a rare metal, discovered by Del Rio in a Mexican red ore, and named by him "erythronium," in 1801; but Collet-Descotels asserted it to be chromium. In 1830, Seffström discovered it in iron ore, and gave it its present name after Vanadis, the Scandinavian Venus. Since then Wöhler has determined the identity of erythronium and vanadium, it having been found by him in pechurane, by Gustav Rose in the pyromorphite of Beresow, and by M. Canaval in the lead ore of Carinthia. In the *Journal de Pharmacie* we learn that it has been found by M. H. Deville in the ferruginous clays in the south of France, and in the flower-pots made of Gentilly clay by M. Beauvallet—the first time that it has been observed in tertiary strata. In the above-mentioned journal will be found notes of the properties of this metal and its compounds, based on experiments by MM. Czudnowicz and Rammelsberg. Vanadic acid is produced by simple calcination in the air. With metallic oxides it forms colourless or yellow salts, which mineral acids decompose easily, for with the latter vanadic acid behaves like a base. M. Czudnowicz has recognised three degrees of oxidation of vanadium.—*Illustrated London News.*

ALUMINIUM.

A NEW method for obtaining this metal at a very small cost has just been discovered, says *Galignani*, by M. Corbelli. He takes a certain quantity of pure clay, say 100 grammes, and dissolves it in six times its weight of concentrated sulphuric, nitric, or hydrochloric acid. The solution is then allowed to stand, and afterwards decanted. The residue is first dried and then heated to 450 or 500 degrees Centigrade; after which it is mixed with 200 grammes of prussiate of potash, which may be increased or diminished according to the quantity of silica contained in the clay. To this mixture 150 grammes of common salt are added. The whole is then put into a crucible and heated until the mixture becomes white: when cool, a button of pure Aluminium is found at the bottom of the crucible.

THE METAL AMMONIUM.

THE abridgment of a paper on the combinations of this remarkable metal, by M. W. Weyl, appears in the *Chemical News*, No. 246. He seeks to explain how far the volatile alkali ammonia

may be reconciled with the existence of the metal, his arguments being strengthened by his having produced a new ammonium, and by the mode of its formation and decomposition. The details cannot be abridged perspicuously. He states that he first sought to obtain a mercuric oxide of ammonium to use for the production of other compounds with electro-negative bodies, which he effected by making dry ammoniacal gas act upon yellow oxide of mercury. In air the new compound rapidly absorbed carbonic acid and lost ammonia, the same taking place over carbonic acid. Rapidly heated in a flame, it became brown and exploded most vehemently; but by a very careful and gradual rise of temperature even thirty grains were decomposed without explosion.

BISMUTH.

Bismuth being now an expensive metal, M. Balard has suggested a method of obtaining it from old printing-types. He dissolves the metal in nitric acid, so as to transform all the tin into metastannic acid, which he isolates by filtering the acid solution from the nitrates of lead and of bismuth; it is then washed with acidulated water, dried, and reduced by charcoal. In the liquor, neutralised as much as possible, are plunged laminæ of lead, which precipitates all the bismuth in the metallic state, which is then dried and placed under a reducing influence. The lead is precipitated from the last liquor by carbonate of soda; it is then dried and reduced by charcoal. The three metals are thus obtained in the metallic state.

PREPARATION OF CALCIUM.

Mr. E. Sonstadt, who has done so much for obtaining magnesium in larger quantities, has laid before the Philosophical Society of Manchester another method of procuring Calcium, the metal derived from lime by Davy, by means of the voltaic battery, at the Royal Institution, in 1808. M. Liès Bodart suggested that the calcium might be got from its iodate; but the latter is found to decompose during fusion and give place to the production of lime, on which sodium has no action, and which prevents the fragments of calcium from uniting as globules. Mr. Sonstadt remedies this by melting together equivalent quantities of the chloride of calcium and the iodate of potassium. The melted mass is poured into a covered iron crucible and left to cool. To the product is added rather less than its equivalent of sodium, in small pieces; it is then covered again with the saline mixture above mentioned. After the closed up crucible has been heated to redness, and the reaction, which is not very violent, has ceased, the metal is found in the form of a globule.—*Illustrated London News.*

ACTION OF CARBONIC OXIDE UPON IRON.

M. Marguerritte has read before the French Academy of Sciences a paper in which he concludes that pure carbon (the diamond) and carbonic oxide can transform iron into steel, and therefore ought to be numbered among the elements of the manufacture ("cementation"). At another meeting of the Academy, M. Caron expressed his dissent from this opinion, and gave his reasons for considering the action of these two substances as very insignificant and even null in the process. He concludes by asserting that M. Marguerritte would arrive at the same conclusions if he repeated his experiments on specimens of iron suitable for forging and for undergoing the trials to which it is subjected when it is worked so as to retain the nature and quality of steel.

USEFUL APPLICATIONS OF SLAG FROM IRON SMELTING.

Dr. Paul states Slag to be of a nature between porcelain and glass. Attempts had been made to cast the slag into blocks as it issued from the furnace, to be afterwards used as artificial stone, but all attempts of this kind had failed. The application proposed with slag at the present time was to convert it into bricks for building. This was done by a simple and ingenious contrivance. An experimentalist had succeeded in blowing the slag into a state of very fine division by sending steam or air into it, just as it flowed from the blast-furnace in the liquid state. It was thus blown into a substance resembling wool in appearance. This substance was taken and ground into dust, mixed with lime, subjected to powerful pressure, and made into bricks, of which he exhibited some examples. These bricks required no fire. After being pressed they were allowed to dry, and could be used at once, the influence of the atmosphere producing a slow kind of hardening. It was also intended to use the powder as a manure.

PRESERVATION OF IRON-PLATED SHIPS, ETC.

In reference to our notice of M. Becquerel's researches on the Preservation of Iron in Water (see p. 64, *ante*), it is stated in the *Illustrated London News*, that in 1858 the writer and Mr. Johnson, of Manchester, covered various pieces of iron plate with zinc, the latter being the twentieth, fortieth, eightieth, and one hundredth of the thickness of the iron; and, after immersing them in the sea, found, at the expiration of one, two, and three months, that the zinc had exercised a remarkable preservative effect. They brought the matter under the notice of Mr. Robinson, a ship-builder, of Newcastle, but his illness prevented the prosecution of the matter. They were afterwards induced to experiment with galvanised iron. Plates of iron three inches thick were attached with great care to pieces of oak of the same surface, and immersed in soft and sea water; and similar plates of galvanised iron, similarly attached, were also immersed. By corrosion the pieces of wood and iron put in distilled water had lost 1·23 per cent., in sea-water 2·400 and 2·380, while the wood and galvanised iron in distilled water had lost only 0·100 and 0·125; in sea-water, only 0·95

and 0·90. Immersion for a longer period gave corresponding results, proving the great protecting action of zinc, both on behalf of wood and iron, especially against the injurious action of sea-water. The writer adds that it was ascertained in a most satisfactory manner that the zinc was not liable to be removed from the blocks of iron by intense friction.

STEEL-MAKING.

By means of graphite, having been referred to by M. Regnault, M. Caron has been induced to make experiments, which he has reported to the French Academy of Sciences. A bar of iron one centimetre square and thirty centimetres long was heated in a large earthen tube filled with new graphite broken into pieces about a cubic centimetre in size. The air had access at the extremities imperfectly stopped by two pieces of graphite; and the tube of porous earth permitted the entrance of the gases of the furnace fed by graphite of the same kind. The tube was exposed to a cherry-red heat for six hours, at the end of which time the bar was drawn from the tube, hammered, and tempered, preparatory to its examination. The metal was fibrous; it could hardly be bent, when cold, without being completely shattered; its surface was easily acted on by the file; in fact, it gave no trace of having become steel. Other experiments gave similar results. M. Caron says that graphite is not the only carbon incapable of transforming iron into steel. Lampblack, probably coke, and all the carbons deprived of alkalies and carburetted gases, will give the same results.

MANUFACTURE OF STEEL.

M. Julien, formerly director of the Loriette Steel Works, has communicated to the French Academy of Sciences a note on the conversion of iron by means of graphite, thus superseding charcoal in the Manufacture of Steel. In the year 1858, M. Julien received from MM. Petit and Gaudet a ton of natural graphite from Germany, with an invitation to try it in place of charcoal. For this purpose he had made small iron boxes, in which he placed the bars to be converted, surrounded by graphite reduced to powder, and strongly compressed. They were then closed by a cover, and all air excluded. The boxes, placed in the midst of the furnace, gave a description of steel differing in no way from that in the other parts of the furnace. This fact is in direct opposition to the assertions of M. Caron on one hand, and M. Fremy on the other. The graphite was pure, and in most of the essays previously calcined. The rest of the ton was employed at the foundry, instead of charcoal, to be mixed with the iron for spring steel: in 7000 or 8000 kilos. of ingots thus manufactured there was no difference between them and ordinary steel. This is the less surprising, considering that when he made these experiments M. Krupp was said

to use nothing else in his works. It is plain, then, that carbon alone enters into the conversion of iron into steel. As far as this goes, he is of the same opinion as M. Margueritte, but not so with regard to the conversion of iron by the oxide of carbon. He regrets that reasons, of too great length to be detailed here, authorise him to affirm that the oxide of carbon (carbonic oxide gas) does not convert iron. If, then, M. Margueritte has obtained steel, and not burnt iron, by causing a stream of carbonic oxide gas to pass over iron heated to redness, that arises from his carbonic oxide gas, as is the case with common street gas, containing carbon in solution. Let the carbonic oxide gas, prepared as he indicates, be submitted to analysis, and it will be found to contain more carbon than enters into the composition of the gas.—*Mining Journal.*

ALLOYS CONTAINING TUNGSTEN.

Caron has instituted a series of experiments, by order of the French Minister of War, to determine the influence produced by Tungsten upon the qualities of bronze, cast-iron, and steel. The addition of tungsten to cast-iron was found to increase both the hardness and tenacity in about the same ratio with the quantity of tungsten added. Even a small percentage, not exceeding one per cent. of tungsten, was found to exert a marked influence, the grain of the iron becoming regular, fine, and grayish, and the fracture showing great homogeneity. The addition of tungsten to steel was found always to increase both its hardness and its tenacity. The author succeeded in obtaining a steel of similar quality by fusing together in an earthen crucible at a very high temperature, 200 grammes of highly-carburetted steel, 800 grammes of good iron, and 20 grammes of tungsten. In conclusion, Caron confidently recommends the employment of tungsten to improve the qualities of steel, and shows that with tungsten at 3f·70 the kilogramme, the price of steel would be increased by only 7 or 8 francs the 100 kilogrammes.—*Annales de Chimie.*

KUHLMANN ON THE COLOURING MATERIAL IN MINERALS.

In the course of his new researches on the preservation of materials employed in building and ornamentation, this able investigator has availed himself of the new methods of analysis by the spectrum, with modifications. He expresses his belief that he has placed in the hands of chemists a sure, simple, expeditious, and safe method of analysing the largest part of the silicious stones, and a great number of natural and artificial silicates; and that he has put investigators in the right way of finding out the true cause of the colour of certain stones; and, finally, that he has opened up a new field of research in spectral experimentation, in analysing by the gaseous way those minerals whose character so much depends on the nature of the solvent engaged in their formation. For details, we must refer to the *Comptes Rendus* of the French Academy of Sciences, Vol. lviii., No. 13.

THE ABSORPTION OF METALLIC POISONS

By plants and by arable land has been made the subject of research by M. de Gorup-Besanez, with the view of ascertaining whether plants really do take up from the soil the metallic poisonous principles which it contains in the state of mixture or chemical combination. He operated with arsenious acid, the carbonates of copper, lead, and zinc, and the oxide of mercury. He found that plants do not absorb these principles from the soil, or only in very small quantities; that arable land possesses a notably absorbing power in regard to metallic salts; but that it takes up the oxides only and not the acids, as the latter are found in the waters that traverse the earth. Arsenious acid and the oxide of antimony are only partially retained. It is important to notice that the nature of the soil is not without influence upon this absorbing power, and that the principle of the soil which possesses this property has yet to be ascertained.

NEW METHOD OF DETECTING ARSENIC, ANTIMONY, ETC.

Dr. W. B. Herapath has read to the British Association a paper on a "New Method of Detecting Arsenic, Antimony, Sulphur, and Phosphorus, by their Hydrogen Compounds, when in mixed Gases." Dr. Herapath having to investigate a case of suspected poisoning by phosphorus, in which the traces of free phosphorus had disappeared, during the long interval between administration of the poison and analysis, he examined for phosphorous acid by Scherer's method; but as several of the hydrogen compounds of sulphur and arsenic, for instance, have the property of blackening the salt of silver, he eliminated these hydrogen compounds from the gas, before its absorption by ammoniacal nitrate of silver, or tested the gas as it was being evolved from any of their compounds. Dr. Herapath dissolved in dilute hot hydrochloric acid the organic matter, stomach, intestines, and contents; the room of operation being at the time quite dark, an apparatus was fixed for exhibiting any phosphoric flashes of light as in Mitscherlich's experiment: no flashes appeared. The acid solution might, however, have contained arsenic phosphorus as phosphorous acid, antimony as chloride, and sulphur as taurine, &c. No chlorate of potassa could be employed in oxidizing the organic matter, or phosphorous acid would become phosphoric, and all evidence be lost, for sulphates and phosphates are not reducible in the hydrogen apparatus; to the liquid filtered there was added one-third of spirit of wine, and it was then ready for use. A gas evolution, with funnel and pipe, armed with a tube containing chloride of calcium, and chalk in coarse powder, for the preparation of pure hydrogen gas, was got ready and tested, as usual, for arsenic. To the exit pipe was attached a green glass tube, passing over two or more spirit-lamp flames. The exit pipe was bent at right angles, to go through a wide-mouthed bottle, containing slips of white filtering-paper, dipped in a solution of nitro-prusside of sodium, made alkaline by ammonia, from which the gas was carried to the next bottle, containing ammoniacal nitrate of silver; and there was another exit-pipe leading to a bottle of some salt of lead, as seen in the photograph, or a jet for burning.

The apparatus being ready for use, pure zinc, sulphuric acid, and distilled water were placed in the hydrogen evolution bottle, and the stream of gas allowed to escape through the apparatus, heat being applied to the tubes with spirit lamps. Now, if arsenic had been present it should have produced a crust in the usual place; antimony would, if present, have been deposited at a spot near it; whilst sulphur would partly have been sublimed and deposited in front of the arsenic, and the remaining undecomposed sulphuretted hydrogen gas have communicated a deep purple-blue tint to the paper charged with the ammoniacal nitro-prusside of sodium; whilst the phosphoretted hydrogen, passing unchanged through all these tests, would have been at once seized by the ammoniacal nitrate of silver, and have produced the black phosphide of silver; and the hydrogen escaped through the lead solution without changing its colour, unless the evolution (supposing phosphorus to be present), of phosphoretted hydrogen would have been too violent for the perfect reaction of the silver salt. It was possible to examine the prepared organic liquid with this apparatus, by inserting quantities of only a few drachms at a time into the hydrogen bottle, through the tubulated funnel, and by employing sufficient spirit; no frothing took place to endanger the success of the experiment, which could at any moment be checked by the addition of a little spirit down the funnel. If the tubes showed no deposit, and the paper remained white, neither arsenic, antimony, nor sulphur, could be present. The black precipitate in the silver bottle would inferentially have been phosphide of silver, but it admitted of absolute proof by testing with Scherer's process. The operation being completed, the silver salt was passed through a filter previously washed with acetic or nitric acid, and afterwards with ammonia; and the collected black precipitate submitted to proof by burning the filter paper acting on the ashes with nitric acid, and heat, until oxidized. A single drop of a dilute solution of phosphorous and phosphoric acids furnished abundant evidence of crystals of the ammonia and magnesium salt, when a glass slide with a drop of distilled water on it had been inverted for a few seconds over its flame. When combustion of the gas is to be the method of proof, the silver solution should be removed to a small hard glass jet, inserted in the end of the tube, from the ammoniacal nitro-prusside of sodium bottle, the gas being inflamed may be treated as above; but to get sufficient evidence of minute traces of phosphorus, it would be well to burn the gas in a glass globe, kept cool by damp cloths round it, and the issuing stream of gas passed through a perpendicular tube surrounded by a freezing mixture; and the condensed water collected in a bottle by Mitscherlich's process, by washing out the bottle, tube, and globe with distilled water, and concentrating by evaporation.

The President, Dr. Odling, said this paper had reference to a very important subject. Among the cases of poisoning there had been not a few recently in which phosphorus had been the poisonous agent employed, and the detection of phosphorus had been, until recently, a matter of difficulty. It was of considerable importance to have the means of distinguishing between arsenic, antimony, and phosphorus, so that, in searching for phosphorus, if arsenic happened to be there, they should come upon it, and so on. The process which Dr. Herapath had adopted appeared to be very satisfactory.

POISONING OF WATER BY LEAD PIPES.

Professor H. Dussance, of New York, has recently made a series of experiments on the action of several different kinds of Water on Lead, under various conditions. The lead was subjected to the action for twenty days, and the experimenter draws the following conclusions :—1. That distilled water has no action whatever on lead by three days of contact; after that time this dissolving action begins. 2. That the lead is dissolved by distilled water in proportion increasing every day: the distilled water exposed to the open air dissolves more of this metal than distilled water in close vessels, or than distilled water deprived of air and gas. 3. That creek water, containing small proportions of lime, has no action on lead. 4. That distilled water, containing 1-3500th of a salt in solution, prevents the dissolving action of the water on lead. 5. That water dissolves lead till the saturating power of the acid is exhausted. 6. That, in ferruginous water, all of the iron is precipitated by lead; then lead pipe must not be used to convey mineral waters. This fact has never been noticed before. To render these facts more interesting, another series of experiments must be made to ascertain the quantities of lead dissolved daily in the water, and what compound it forms, and to see if the action will be the same in the lead pipes.

Among all the dangers arising from carelessness, the public may not be aware that there is great danger in the careless use of even hydrant water. That water, impregnated with any preparation of lead, cannot be safely used for culinary purposes, even in cases where the lead is present in too small a proportion to produce any immediate injury, is well known. Lead, says Professor Aikin, of New York, like some other poisonous agents, when taken in minute successive doses, will remain in the system, apparently inactive, until a certain amount accumulates; then, suddenly, a series of alarming symptoms will supervene, often resulting in death. An occurrence of this kind was recently brought to my notice by one of my professional friends, who was called upon to subscribe for several members of the same family, all apparently suffering from the peculiar action of lead. In one of the cases the result was fatal—the others, after much suffering, slowly recovering. A portion of the water supposed to have been instru-

mental in producing the difficulty was brought to me for examination, and carefully analyzed, and found to contain lead in the proportion of 0·028 gr. to the gallon of water. This very minute quantity, very little exceeding 0·001 gr. to an ordinary tumbler full of water, taken at intervals somewhat regularly, seems to have accumulated until the poisonous action of the metal was developed. The whole difficulty seems to have arisen from the occasional use of water taken from a hydrant stop that was not in regular and frequent use; the water in a portion of the lead pipe being thus allowed long-continued contact with the metal in the immediate vicinity of the stop. The simple precaution hereby indicated, and one that cannot be neglected with safety, is to allow the first discharge of water from any hydrant stop to run to waste, and not to collect any for culinary purposes until we are sure that all the previously stagnant water in the lead pipe has wholly escaped. And it would be better, in general, to resort to the yard hydrant for water required for drinking or preparing food—the lesser length of lead pipe there in use diminishing the danger. But even there the water first discharged in the morning should be thrown away.—*Mechanics' Magazine.*

Professor Voelcker has also illustrated this subject to the Royal Agricultural Society. The Professor's conclusions are—

"We have three conditions which will account for the great action that some waters exercise upon lead. The first is, the presence of organic matters; secondly, the presence of alkaline salts or alkalies; and, thirdly, the absence of carbonic acid. There are soft waters which do not act upon lead; and there are, on the other hand, hard waters that rapidly act upon lead. Now, in order to exhibit correctly the action of alkaline matters, I have here a piece of leaden pipe which has been brought into contact simply with water; and you will notice how the quick-lime, which is an alkali, acting in a small way like the carbonate of soda that we have in some waters, acts upon the lead. It causes it to become converted into oxide of lead. The pipe itself has been converted almost entirely into litharge; for this reddish powder is an oxide of lead. Indeed, it is worn into a thin film or sheet. It appears that all alkaline earths like lime have this effect, causing the lead to change rapidly into oxide of lime, which you will observe is an incrustation. I have analyzed the sample I have in my hand, and find it to be nearly pure litharge. In laying down water-supply pipes, particular care should be taken not to put them in cement, but to surround them by gravel. Pipes are frequently eaten away in consequence of inattention to this point. They should never be put in cement, then, for the lime acts upon the lead. Sometimes tanks and water systems are rapidly eaten away by the water acting upon the lead. A very good protection is to throw into the leaden tank a few pieces of zinc. Zinc is more readily attacked than lead; and as long as there is any zinc present, it is eaten away and changed into oxide of zinc before the lead is attacked. We have thus a most simple and effective means of protecting leaden tanks against the corrosive action of some waters. However, I would not recommend such waters for drinking purposes, for zinc is a metallic substance, which is injurious; but when the water is intended to be used for feeding steam-boilers, then the addition of a few strips of zinc as large as my hand, thrown into the tank, without soldering, protects the lead very well against the action of the water. It is fortunate that when lead even finds its way into the water it is removed again on standing in the air. Air contains carbonic acid, and in contact with carbonic acid the lead which has passed into the water becomes again precipitated. Carbonate of lead is insoluble; and filtration through an ordinary water-filter also completely deprives the water of its lead. The danger, then, of poisoning by lead, or by water containing lead, is very much less than is usually believed. Indeed, we have no direct

evidence of water having had injurious effects upon the health of those who use it, that can be referred to the presence of lead. I do not think there is a single instance on record in which the presence of lead in water has proved injurious; for, at the most, only small quantities of lead can find their way into the water, and it is again rapidly and certainly removed by standing and by filtration."

MAGNESIUM AND ITS LIGHT.

THE metal Magnesium was obtained from its earth, by means of the voltaic battery, by Sir Humphry Davy, in 1807. It remained little else than a chemical curiosity until 1862-3, when Mr. Edward Sonstadt patented a series of processes, whereby it may now be produced in any quantity. Magnesium is a metal white as silver, and very light; its specific gravity being 1·74, or about one-fifth the weight of copper.

In the *Proceedings of the Royal Society*, No. 63, are reported some researches of Dr. T. Phipson on this metal, now becoming so interesting in relation to its illuminating properties. He states that magnesium is capable of reducing silicic acid at a high temperature, which the alkaline metals sodium and potassium cannot do, as they volatilize before the crucible attains the proper heat. It decomposes carbonic acid from dry carbonate of soda, and it precipitates nearly all the metals from their neutral solutions. Unlike zinc, it will not unite with mercury at the ordinary temperature of the air. With platinum, according to M. Sonstadt, it forms a fusible alloy; and it is probable that an alloy of copper and magnesium would differ from brass not only in lightness but by being able to decompose water at the ordinary temperature with more or less rapidity. This last effect is also produced by combination of sodium and potassium, which are very malleable alloys. Magnesium will be found a useful metal whenever tenacity and lightness are required; and where tarnish is of no consequence. It is especially valuable in the laboratory for effecting decomposition, which sodium and potassium cannot effect on account of their greater volatility.

The supply of Magnesium is inexhaustible. Immense quantities exist in the form of stratal rocks, and the ocean abounds with it. When pure, the metal is white as silver, and it readily receives a high polish, and is easily kept clean. In some cases it is very tough, but in others it is brittle, in this resembling zinc and aluminium itself. Improvements in the economy of its production are still being made. M. Sonstadt produces it by a new process. It is interesting to witness the production of wire from a mass of magnesium by hydraulic pressure through a small orifice, from which it issues like a little stream of silver, but solid. It is said that 2½ oz. of this magnesium wire will give out as much light as 20 lb. of the best stearine. At this rate magnesium is already not much dearer than composite candles. Mr. Grant, by burning a strip of zinc in conjunction with two strips of magnesium, is able to reduce the cost of the light by two-thirds.

The wire may now be purchased at 3d. per foot at all the principal metallurgists, opticians, and photograph-material dealers. If the end of a piece of wire be held in the flame of gas or candle it at once takes fire and burns gently, with a dazzling white light, by which a photograph may be taken with a perfection equal to sunshine.

A very ingenious and simple lamp is the invention of Mr. Grant, the Nottingham photographer, which effects the object in view very satisfactorily. The double wire is coiled on spools, and thence is drawn between cylinders to a tube, through which it is thrust at precisely the rate at which it burns by clockwork. Nothing can be more simple and effectual. The apparatus will form either a hand lamp or may be applied for other purposes, such as the lighting of theatres, the making of fog signals, or signals of any kind. The hand lamp will be especially useful to photographers. By its assistance they will be able to take portraits in less time at night by the magnesium light than they can now in the daytime by the sun.

Mr. Grant has likewise ascertained that certain alloys, into the composition of which magnesium enters largely, are capable of affording nearly as brilliant a light as pure magnesium, and of colours varying with the metal mixed with it: thus, one part zinc and two parts magnesium produce an alloy which burns readily, and gives a slightly blue tinge to the flame; one part of copper and three of magnesium give a green light; one part of strontium and two of magnesium give a red light. Mr. Grant has already succeeded in burning twelve different metals in combination with magnesium, and in some cases has been enabled to diminish the expense of burning to one-third the original cost per hour.

Another extraordinary fact is this, that the magnesium flame gives off no noxious fumes—no sulphurous gas, carbonic acid, sulphuretted hydrogen—blacks and stink, and heat and wet—damaging paper-hangings and the finest furniture, corroding metals, and injuring health. The burning of magnesium simply produces the oxide, magnesia. Nor is there any risk of explosion, as in the case of gas and some oils. The value of magnesium as an illuminator for the purpose of signalling is too obvious to escape immediate recognition. The portable nature of the contrivance, and its perfect immunity from risk of explosion, together with some other evident advantages, render its vivid light all the more practically valuable.

JAPANESE PAPER MATCHES

Have been exhibited by Dr. Hormann to the Chemical Society. From the *Chemical News* we learn that, when lighted, these matches burnt with a small, scarcely luminous flame, a red-hot ball of glowing saline matter accumulating as the combustion proceeded. When about one-half of the match had been consumed

the glowing heat began to send forth a succession of splendid sparks. The phenomenon gradually assumed the character of a brilliant scintillation, very similar to that observed on burning a steel spring in oxygen, only much more delicate, the individual sparks branching out in beautiful dendritic ramifications. The mixture had been found quite free from metallic constituents, and to contain carbon, sulphur, and nitre only. These constituents were present in the following proportions :—Carbon, 17·32 ; sulphur, 29·14 ; nitre, 53·64. Each match contained about 40 milligrammes of the mixture, which was folded up in fine paper. There had been no difficulty in imitating these matches. A mixture of carbon, 1 (powdered wood charcoal) ; sulphur, $1\frac{1}{2}$; and nitre, $3\frac{1}{2}$, produced the phenomenon in even a more striking manner. The choice of the paper was not without importance. Ordinary English tissue paper might be used. The finest matches are, however, obtained by employing genuine Japanese paper.

THE THEORY OF THE DAVY-LAMP

Is the subject of re-investigation through the progress of research into the true nature of heat. From the *Philosophical Magazine* we select these remarks :—Davy referred the action of his Safety-lamp to the cooling action of the wire-gauze. Dissatisfied with the inadequacy of this, Krönig proposes the following :—Although experiment shows that a wire-gauze can cool the gaseous products of combustion present in a flame to a point below the temperature at which they ignite, the question arises, on what does this action depend? Several things are possible. A cold wire-gauze introduced into the flame can take away heat. But the cooling thus produced is less the higher the temperature of the gauze rises ; and a continuous cooling of the flame by the wire-gauze is only possible when the wire-gauze loses on the outside the heat it receives from the flame. Such a loss can occur either by conduction or by radiation. If the flame is small, heat may be conducted from the middle parts of the heated wire-gauze ; but this conduction must be less the greater the flame. Hence it is probable that the wire-gauze loses heat more by radiation than by conduction. "The assumption that metal-gauze radiates more heat than the gaseous flame is a matter of course, for we know that ignited solid bodies radiate more light than gaseous bodies at the same temperature." This opinion (says Krönig) has become a certainty since the publication of Magnus's interesting experiments in his paper "On the Constitution of the Sun." For not only does he show that the introduction of a disc of platinum into a non-luminous gas-flame causes it to radiate more heat, but also that this radiation experiences a further increase when the platinum is soaked in carbonate of soda. This observation appears completely to explain the statement of Graham, that the wire-gauze of the safety-lamp soaked with solution of alkali becomes much more impervious to the flame.—*Illustrated London News.*

HYDRO-CARBON LIGHT.

At the Queen's Hotel, St. Martin's-le-Grand, the Rev. W. R. Bowditch, of Wakefield, has explained the advantages of an invention which he has patented. Gas on its way to the burner is made to pass through a metal box containing Hydro-Carbon (which does not seem to be new, however), when vapour is generated by the heat of the jet and mixed with the gas as supplied to consumers, so increasing the brilliancy of the gas. The necessity of having the box containing the hydro-carbon suspended above the gas jet may be an obstacle to the introduction of the process in many cases ; but it might, perhaps, be made to assume the shape of a smoke-collector, thin round the outer edge and hollowed in below.—*Builder.*

A NOVEL APPLICATION OF THE SLAKING OF QUICKLIME

Has been proposed by Dr. John Davy (brother of Sir Humphry), in the *Edinburgh New Philosophical Journal.* It is well known that as soon as water is added to and absorbed by well-burnt lime fresh from the kiln an immediate union takes place, the mass becoming broken up and falling into powder, with the production of much heat and steam. This does not take place when the lime has been exposed to the action of the air for two or three days ; during which the lime gradually absorbs a little water. With respect to these phenomena, Dr. Davy records the results of several experiments, which showed the explosive power of the lime when placed in holes or receivers, and treated with water, or with solutions of common salt, carbonate of ammonia, &c. We have no space for the details which lead Dr. Davy to suggest the application of the explosive force of lime to the blasting of rocks and similar purposes, but give an account of two of his experiments. A boring was made in a block of sandstone about fifteen inches deep and two inches in diameter ; this was filled with small pieces of quicklime, and the hole was closed by a plug of wood. No rending ensued, although the hydrate was formed. The elastic expansive force was not superior to the resistance, and the steam was condensed. A second experiment was made, substituting for the boring in a rock a strong earthenware jar, capable of holding about a quart. It was similarly charged, and tightly corked, the cork bound down firmly by a cord. After about fifteen minutes an explosion took place, with a report like that of a pistol. The jar was broken in several pieces, and some of them were projected many yards from the spot. Now, as coal is not nearly so resisting as sandstone, and as its boring is easily effected, Dr. Davy expresses the hope that the experiment may be repeated in a colliery. It is easily made, at a cost not worth mentioning ; it is attended with no serious danger ; and, should it be successful, it may conduce to the saving of many valuable lives.—*Illustrated London News.*

CONDUCTION OF HEAT.

In relation to Tyndall's researches, M. l'Abbé Laborde states that he heated to redness one end of a thin iron bar so long that the other end could be held without burning. When the red end was plunged into water the other end became so hot that he was compelled to drop it. The rapid compression of the hot metal, he says, is no doubt the cause of the elevation of temperature; but he asks if another cause may not be suspected; for instance, the creation of thermo-electric currents? For this purpose he made a rather rough experiment, which is described in *Les Mondes*, Vol. vi., No. 1.

NEW MATCH.

The dangers arising from the universal adoption of the common lucifer match have induced chemists to seek a substitute for it. M. Peltzer has recently proposed a compound which is obtained in the shape of a violet powder, by mixing together equal volumes of solutions of sulphate of copper, one of which is supersaturated with ammonia, and the other with hyposulphite of soda. A mixture of chlorate of potash and the above powder will catch fire by percussion or rubbing; it burns like gunpowder, leaving a black residue. M. Viederhold proposes a mixture of hyposulphite of lead or baryta, or chlorate of potash, for matches without phosphorus. The only inconvenience of this compound is, that it attracts moisture too easily.

TEMPERATURE OF THE SEXES.

Dr. J. Davy has communicated to the British Association the results of some experiments he had made as to the relative Temperature of the Two Sexes. The theory of Aristotle, that a man possessed more warmth than a woman, had been disputed; and it had been held by some, as the result of modern research, that the temperature of women was slightly superior to that of men. Notwithstanding this, however, from such observations as he had been able to make, he considered the early opinion the more correct. Taking the average, it appeared that the temperature of males and females was as 10·58 to 10·13. He had more recently made some additional observations, using a thermometer of great delicacy, and taking for the purpose of his experiments six persons, three men and three women, all in good health. The result was, that the temperature in the case of the men varied between 90 and 99½, that of the women was between 97¾ and 98. An examination of other animals gave a somewhat higher temperature for the male than the female; six fowls showing the proportion of 108·33 for the former to 107·79 for the latter.

CHEMICAL PHOTOMETER FOR METEOROLOGICAL OBSERVATION.

Professor Roscoe has explained to the British Association the principles upon which the method of measuring the chemical action of light depends, and described the results which he had obtained in Manchester. By means of this instrument it is easy to obtain the daily curve of chemical intensity of the sunlight at any spot, and the whole apparatus is of a very simple and compendious description.

LUMINOUS AND OBSCURE RADIATION.

Professor Tyndall, in the *Philosophical Magazine* for November, details his numerous experiments demonstrating the character of the Radiation from a hydrogen flame under a variety of conditions, the apparatus employed, and the results obtained. We select a few of the latter. Fifty experiments on the radiant heat of a hydrogen flame make the transmission of its rays through a quantity of iodine, which is perfectly opaque to light, 100 per cent. To the radiation from a hydrogen flame the dissolved iodine is therefore perfectly transparent. It is also sensibly transparent to the radiation from solid bodies heated under incandescence, and to the obscure rays emitted by luminous bodies. Professor Tyndall found that, dividing the radiation from a platinum wire raised to a dazzling whiteness by an electric current into twenty-four equal parts, one of these parts is luminous, and twenty-three obscure; dividing the radiation from the most brilliant portion of a flame of coal-gas into twenty-five equal parts—one of those parts is luminous and twenty-four obscure; dividing the radiation from the electric light emitted by carbon points and excited by a Grove's battery of forty cells, into ten equal parts, one of these parts is luminous and nine obscure.

The following conclusions are very remarkable:—"On a tolerably clear night a candle flame can be readily seen at a distance of a mile. The intensity of the electric light used by me is 650 times that of a good composite candle, and as the non-luminous radiation from the coal-points which reaches the retina is equal to twice the luminous, it follows that at a common distance of a foot the energy of the invisible rays of the electric light which reach the optic nerve, but are incompetent to provoke vision, is 1300 times that of the light of a candle. But the intensity of the candle's light at the distance of a mile is less than a 20,000,000th of its intensity at the distance of a foot; hence the energy which renders the candle perfectly visible a mile off would have to be multiplied by 1300 × 20,000,000, or by 26,000,000,000, to bring it up to the intensity of that powerless radiation which the eye receives from the electric light at a good distance. Nothing, I think, could more forcibly illustrate the special relationship which subsists between the optic nerve and the oscillating periods of luminous bodies. The nerve, like a musical string, responds to the periods with which it is in accordance, while it refuses to be excited by others of vastly greater energy which are not in unison with its own."—*Abstract, in the Illustrated London News.*

ARTIFICIAL LIGHT AND LIGHTING MATERIALS.

A PAPER on this subject has been read at the Society of Arts by Mr. B. H. Paul. In speaking of the history of Lighting Materials, mention was made of the fact that, just before "gas" was discovered, mineral oils of the petroleum or paraffine class were being tried with every prospect of success. These oils were distilled, as they still are in some cases, from bituminous shale and other minerals. Although the introduction of gas completely superseded the mineral oils at that time, works were established in France in 1830 for the manufacture of artificial petroleum, and these are still in operation. Somewhat later, other works were started in other parts of the Continent as well as in this country; and about the year 1853, the earth oil of Rangoon was examined by Mr. Warren De La Rue and Hugo Müller, with a view to its application for lighting purposes. About 1860, the extraordinarily abundant supplies of petroleum in America became the object of special interest as materials for lighting. One object of the paper was to consider the charging of atmospheric air with volatile mineral oils, on the principle discovered and patented by the late Mr. Mansfield many years ago, and recently brought out as a new French invention. The danger of explosion was, under certain circumstances, admitted; but it was considered possible to make arrangements for completely obviating that objection, so that these oils might be burnt like gas without any danger of an explosive mixture being formed.

USES OF PETROLEUM.

THE properties of Petroleum Oils have been described at pp. 52—54 of the present volume; together with a notice of the use of Petroleum as a steam fuel. In the *Scientific American* it is stated that a Government Commission has investigated, by actual experiment, the process of using hydro-carbon oils for the generation of steam, by the method and process of Messrs. Shaw and Linton, of Philadelphia.

This Commission made a series of careful experiments, extending over a period of five months, which have proved highly satisfactory. From their Report we extract the following :—

"The volume of flame was so great as to pass entirely through the tubes of the boiler, and heat the smoke-pipe red-hot for several feet from the base, in consequence of which the maximum amount of combustion and evaporation was not reached in the use of petroleum.

"The evaporation in favour of petroleum was 103 per cent., as shown by the report; the same boiler being used with the best anthracite coal, and under precisely the same condition.

"The time of generating steam from water of equal temperature to 20 lb. pressure above the atmosphere was, for the oil, an average of 23 minutes, and for the coal 60 minutes; or in favour of the oil 114·3 per cent.

"The time from full operation for the complete extinguishment of the fire in the use of the oils was about 16 seconds. One of our iron-clads or naval steamers, by its successful use as suggested in the experiments so far as tried, would be enabled to keep the sea under steam three times as long, with less labour and greater convenience as compared with the use of coal, equal weights of each on board being considered."

These advantages, as set forth in this Report, are very great, and, if true, a complete revolution in the mode of generating steam will be the result. The Commissioners accordingly recommended the Secretary of the Navy to introduce the oil on board one of the Government steamers, to determine practically its economical efficiency.

In addition to the discovery of extensive deposits of the oil in Southern Russia, large quantities are alleged to have been found on the Pacific, in California.

The Michigan petroleum, lately discovered, has been analyzed, and found to be of a very superior quality. It has less odour than the crude Pennsylvania oils, and will yield 20 per cent. more of the refined article than the former. Its specific gravity is 40 deg. That of the Pennsylvania oil ranges from 45 deg. to 47 deg. Albion petroleum is easily deodorized, and, when refined, makes a clear white oil that burns freely, and is entirely non-explosive. It yields but little naphtha, and stands a fire-test of 140 deg.

It is erroneous to imagine that experimental inquiry in this path of science is confined to America. Very recently a locomotive was fitted, on the St. Helen's Railway, to burn coal oil, on a system proposed by Mr. W. B. Adams.

In France, by experiments it has been proved that the oil will generate as much steam-power in twenty-eight minutes as coal in an hour. Then there is the great saving of stowage, and an economy of expense by which it is asserted that 77,000 frs. would be saved in one voyage across the Atlantic.

Mr. J. Turner Hall, gas engineer, has succeeded in constructing a signal lamp and lantern in which petroleum may be used with perfect safety, and a brilliant and uniform light be obtained. The light is not affected by gusts of wind. It is already in successful operation in several of the stations on the London and North-Western Railway. In addition to its employment for railway signals, it may also be used for lighting coal and other mines, lighthouses, and similar places. It is said that whilst the new petroleum lamp gives a large excess of illuminating power, the actual cost as compared with other oils is less by upwards of 50 per cent.

The *Polytechnisches Journal* speaks of a new outlet of earth oil in the rich and remote province or principality of Wallachia. The general result of Dr. Otto Buchner's analysis is, that the Wallachian product is a valuable contribution to commerce and industry, although he does not think it has demonstrated its fitness to compete with the petroleum of Pennsylvania. Dr. Buchner, however, has not found his experiments confirm the assertion of American analysts, that the lighter Pennsylvania oils of a specific gravity of 0·80, give 90 per cent. of burning oil. His highest result has been 70 per cent., of which from 15 to 20 per cent. was of benzine.—*Mechanics' Magazine.*

GLUCOSE.

The transformation of sugar into Glucose (grape sugar) by heat has been effected by M. Morriez, by submitting two syrups, in two vessels of equal capacity, to a regular ebullition during ten hours, the evaporated water being exactly replaced so as to maintain the same level in the two vessels. Twenty-six times more glucose was produced in the syrup of the sugar-cane of Martinico than from the syrup of the beet; and by a boiling of eighteen hours the syrup of the sugar-cane was completely transformed into glucose. The total transformation of the beet-sugar into glucose required a much longer period. The rapid transformation of the Martinico sugar is due to the presence of free acid, always found in these sugars.

EXTRACTION OF POTASH FROM MARL.

Mr. G. J. Scattergood, in the *Proceedings of the American Pharmaceutical Association*, describes a method for procuring Potash from the Green Sand or Marl of New Jersey, which contains among other constituents from ten to twelve per cent. of this alkali. The results of the experiments negative the hope of potash ever being economically extracted sufficiently pure for pharmaceutical and commercial use, so as to compete in price with that derived from wood ashes; yet the details are very interesting, since they show the effects of certain agents upon a substance the chemical nature of which is as yet but little known; and the editor of the *Chemical News* has done well in reprinting Mr. Scattergood's letter in No. 246 of his journal.—*Illustrated London News.*

THE MANUFACTURE OF SODA.

M. Scheurer-Kestner, in a communication to the French Academy of Sciences, gives the following résumé of the Leblanc process:—The reaction passes through three phases. In the first moments the sulphate of soda is reduced to sulphur, with the disengagement of carbonic acid; a double decomposition ensues between the sulphur formed and the carbonate of lime; finally, a partial reduction by the carbon of the carbonate of lime employed in excess, and checked by the cooling of the mass. The addition of an excess of lime has a double use: it serves to replace that which is reduced into an oxide in the course of the operation, through the imperfect mixtures; and it permits the seeing the exact moment in which the reaction is terminated. Further details will be found in the *Comptes Rendus*, vol. lix., No. 16.

CHEMISTRY OF WINE.

M. Pasteur's latest paper on this subject appears in No. 3, Vol. xxxviii., of the *Comptes Rendus* of the French Academy of

Sciences. He has been led to the result that the spontaneous changes in wines are correlative with the presence and multiplication of microscopical vegetations, several of which are represented in an engraving. He ascribes acidity in wines to the Mycoderma aceti and Mycoderma vini; and bitterness in them to curious vegetable filaments associated with small brown spherical grains.

CLARIFYING WINES.

The number of eggs employed in Paris alone in Clarifying Wines is about 4,500,000. By this means a wholesome and nourishing article of food is taken away from public consumption, and its price considerably enhanced. To avoid this, certain kinds of powders are now beginning to be employed by which wines may be clarified with equal facility and at a smaller expense.—*Mechanics' Magazine.*

INTOXICATING EFFECTS OF ABSINTHE AND TOBACCO.

In a medical study addressed to Absinthe-drinkers, read at a meeting of the French Academy of Sciences, M. E. Decaisne terminates his memoir by asserting that—1. In equal doses, and with the same degree of concentration as brandy, absinthe produces more injurious effects on the animal economy. 2. It causes intoxication more rapidly, and its influence upon the nervous system resembles more that of an acrid narcotic poison than that of intoxication by alcohol. Although one of the greatest dangers of absinthe exists in the adulterations to which it is liable, yet M. Decaisne asserts that even a moderate use of it in good quality is so injurious that its consumption ought to cease entirely.

At the same meeting a note was read from M. Gallavardin, descriptive of the intoxicating effects produced on various persons by the application of tobacco-leaves to the skin. In the case of a robust peasant, aged twenty-seven, subject to rheumatism, it produced headache, trembling of the limbs, nausea, and vomiting, accelerated pulse, &c. Similar effects were produced by the powder of tobacco mixed with butter, by the juice, and by other forms of this narcotic applied to the skin.

The abuse of Tobacco is stated by M. Decaisne, in a memoir read at a recent meeting of the Academy of Sciences, to produce an intermission of the action of the heart and pulse in certain persons. He found this to be the case in twenty-one persons out of eighty-eight inveterate smokers. This affection, which he terms narcotism of the heart, is curable by suspending or reducing the consumption of tobacco. He stated that neither of the persons subjected to his observation had any lesion of the heart, or was in a state of health likely to lead to it. The exorbitant use of tobacco was the sole cause of the affection.

SULPHATE OF IRON AND VEGETATION.

It is stated as a new discovery that wonderful effects may be obtained by watering fruit-trees and vegetables with a solution of Sulphate of Iron. Under this system, beans will grow to nearly double the size, and will acquire a much more savoury taste. The pear seems to be particularly well adapted for this treatment. Old nails thrown into water and left to rust there will impart to it all the necessary qualities for forcing vegetation.

EXTRACTION AND PRESERVATION OF AROMATA.

In the *Chemical News*, No. 256, Mr. C. R. Tichborne states, that being desirous of preserving a vegetable lusus naturæ for some time, he submerged it in some weak glycerine, considering that that fluid would be less likely to destroy the tender organism, and also remembering that it had been found most efficient in the preservation of animal tissues. The glycerine answered its purpose most admirably, preserving the delicate parts of the plant and preventing decomposition. He immediately saw that this property of glycerine might be made available for certain pharmaceutical purposes, where it was desired to preserve or to extract the aromata of vegetable products, such as elder, orange, or rose flowers, and also might be substituted for the oils and fats used in the process termed enfleurage. The glycerine need not be especially pure, but should be devoid of odour. The elder-flowers should be gathered when the corolla is fully expanded, but not too far gone; they should then be plucked from the stem, and packed firmly in wide-mouthed bottles or jars without crushing them; and the whole should then be covered with glycerine. Mr. Tichborne states that he has thus preserved flowers for two years, and on distilling them, procured a water the perfume of which has equalled the most recent product.

MEDICINAL MUDS.

Dr. T. L. Phipson has sent to the British Association two specimens of the Medicinal Muds of the Island of Ischia. He had no doubt that the water, in its natural state, was strongly impregnated with sulphuretted hydrogen. It was doubtless to the presence of sulphur that muds owed some of the medicinal properties ascribed to them, as it was the only active substance present in them. The black colour of one specimen was owing to a layer of black sulphide of iron formed by the action of the sulphuretted hydrogen upon the grains of green feldspar, which it enveloped completely. When the mud was exposed to the air for some time the black sulphide was gradually oxidized, and the grains assumed their original green colour. The curious custom of plunging the body into muds of this kind, as a means of restoring health, was not confined to the Island of Ischia. The beneficial effects that were said to follow this treatment were probably owing as much to the cleansing and stimulating effect produced by the friction of the grains of sand upon the skin as to the presence of sulphur and sulphuretted hydrogen in the muds.

IODOFORM.

Dr. Righini having examined and tried the physiological and therapeutic qualities of Iodoform, chemically an iodide of formyle prepared by the simultaneous action of iodine, alcohol, carbonate of soda, and water, has found it to possess anæsthetic, antiseptic, and anti-miasmatic qualities. When iodoform is administered slowly and continuously, it causes excess of secretion from the liver, the lungs, the salivary glands, and the loins; the patient, instead of falling off, as in the case when he is treated with iodine, grows rather fat. Iodoform may be administered without any danger in large doses, which may be gradually raised to three grammes per day, but very large doses will cause symptoms of iodism. It is good for tumours, rebellious eruptions, &c.

A NEW PROCESS FOR PRESERVING MEAT,

Proposed by M. Pegliari, has been reported to the French Academy of Sciences by M. Pasteur. It consists in inclosing the meat in a layer of benzoin and alum—a mixture at once anti-hygrometric and antiseptic. The meat thus inclosed and abandoned to the air loses the greater part of the liquids which, by their tendency to decompose, contribute most actively to putrefaction. In the office of the Academy were deposited a leg of mutton and several other pieces of meat, which had been sent from Italy. The mutton had lost much of its freshness and gave out a little odour; but a fine piece of beef did not give the least sign of alteration, and seemed to preserve its original freshness.

DIAMAGNETIC ACTION OF WATER.

Professor Maas, of Namur, in a communication on this subject, made to the Royal Academy of Sciences of Belgium, expresses his opinion that Water is the determining cause of the Diamagnetism of certain organized substance. He states that Faraday, in his work on magnetism, has ranged elder-pith and ivory among diamagnetic bodies. After having observed the diamagnetism of a small prism of elder, he was surprised to find it changed to para-magnetism within a short time. In order to ascertain the cause, he cut from a long cylinder of oldish elder-pith two prisms, using a knife electrotyped with copper. One of these prisms was left exposed to the air, the other was inclosed in a flask containing some drops of distilled water. The first was found to be powerfully axial-magnetic, the other as powerfully

equatorial. M. Maas hence concludes that the water made the latter diamagnetic. Several slices of ivory, cut in different directions from an old piece, equally surprised him, since none placed itself across the axis of the magnets; one placed itself axially, another made a very open angle with the same axis. A third example was a small cylinder composed of starch, gum arabic, and water. Freshly prepared, it placed itself transversely, but when spontaneously dried it became para-magnetic. "Hence," says M. Maas, "we may be permitted to suppose that many natural organic substances owe their diamagnetic property to the interposition of liquids, of which water forms the largest proportion." The apparatus employed in the experiments was a Faraday's electro-magnet, modified by Becquerel and constructed by Secretan. —*Illustrated London News.*

UTILIZATION OF SEWAGE.

Dr. Hughes Bennett, of Edinburgh University, has read to the British Association a paper on "The Physiological Aspect of the Sewerage Question." He commenced by stating that the importance of the subject was now universally recognised. In an economical point of view this country annually lost about 10,000,000*l*. by the non-utilization of sewage, and if account were taken of the cost of the works required to carry off the sewage, the extent of national loss might be doubled. The difficulties in the way of the application of sewage to agriculture arose from three sources—1. From the large admixture of sewage with water. 2. From certain ideas of its prejudicial influence on health. 3. Owing to the nuisance which it was thought by some would thereby be occasioned. All plans for the utilization of this important material were more or less interfered with, in consequence of the assumption that there was something pestiferous or unhealthy in the fermentation, exposure, and smell of sewage. He agreed with Mr. Rawlinson, who was examined before the Committee of the House of Commons, that the health of the people was the first consideration; but he could not agree with him that the risk to public health from the utilization of sewage was such that it was better at any cost to remove it from towns and throw it into the sea. To prove the fallacy of that opinion, and remove some of the difficulties surrounding the question, he laid down the following propositions:—1. That atmospheric air strongly impregnated with odours of various kinds was not necessarily injurious to health. 2. That atmospheric air without smell was often most deadly. From these two propositions he inferred—3. That there was no necessary connexion between smell and deleterious gases. Smells by themselves might be considered as non-injurious. They were not even a nuisance to those who lived among them. The sense of odour was very easily paralyzed. 4. That deleterious gases arising from excreta were injurious, being inhaled from pent-up drains. 5. That emanations from drains and sewage entering running streams were in no way dangerous. 6. That typhoid fever could not be proved to originate from excretal fermentation. 7. That the improvement of drainage by costly works did not necessarily diminish the amount of disease. Typhoid fever in Edinburgh appeared to follow improvement in drainage. Improper food and drink had much to do with fevers. The worst effects were produced by bad water. Decomposed animal matter, by means of cesspools, found its way into our wells. The general conclusion at which he arrived was this—that, so far from sewage being poisonous and injurious to man, it was a source of growth to the vegetable, and through that to the animal, world.

Dr. Livingstone bore testimony that stinks had not been the cause of fever in Africa. He gave one instance in which he had particularly noticed that a very bad smell had no effect whatever on health; although he and his companions, in coming down the Shire, remained for the night in water literally as black as ink, and having a most abominable smell, the white paint of the vessels quite black, the brasswork being turned the colour of bronze, and even the yards discoloured. He inquired among the natives if they had ever observed such a state of things before, and whether fever had followed it. They said no; no disease followed it, and such was actually the fact. They had no fever in consequence of spending the night in that atmosphere. From all his other experience, he came to the conclusion, that whatever the fever might be it did not come from bad smells. He thought bad smells ought to be got rid of as soon as possible; but it would be a great mistake if medical men or others supposed from the presence of a bad smell there must be fever.

Dr. Kirk corroborated what had been stated by Dr. Livingstone. Dr. Budd moved a resolution to the following effect:—"That it is desirable that a Committee be appointed to report to the Association, at some future meeting, 'whether the specific agent which is the cause of typhoid fever be ever created *de novo* out of common sewage, or whether the sewer only propagates this fever by the dissemination of germs contained in the liquid discharges of persons already labouring under the disease.'" After some discussion, the resolution was agreed to.

Mr. W. Gee read the following paper, giving an account of the mode adopted at the Bradford Union (Wiltshire) for the Utilization of Sewage, where the boys' and girls' schools' sewage has been for two years simply, clearly, and effectually deodorized and wholly saved by the Rev. H. Moule's earth method, or the "dry way." It is quite inoffensive, and might be handled by a lady in potting flowers. A discussion followed, in the course of which Mr. Gee exhibited a box of the product, which had the appearance of mixed earth and guano.

Professor Miller, Mr. Young, and several other gentlemen continued the discussion, in the course of which the opinion was expressed that precipitation destroyed the value of sewage as manure; and that the only plan of making the ordinary sewage of

towns available for agricultural purposes was to distribute it on the land in a liquid form.

Mr. Tite said, the whole matter of the disposition of the London sewage had been before him for a considerable time.

The London Sewage was something enormous in quantity. It was collected in immense reservoirs, and then poured into the river at times when it would be swept out to sea. Thus, the whole of the sewage of London, containing important chemical constituents, was utterly wasted. He had no doubt that they should relieve the basin of the Thames completely of the sewage which fell into it from Chelsea to below London; but, with regard to the utilization of the sewage, they did not see their way clearly, and on another point they were in a great difficulty. This point was as to what was to become of the drainage of the large towns above their district, because it was impossible to join them with London, and it was idle to seek to drain Oxford by any lateral drainage that could reach the sea. At the present time Kingston had made arrangements to pour its sewage into the Thames, but was stopped by an injunction obtained by the Conservators of the river, by which they had been taught that such nuisances could not be continued. The question then remained, what was to be done with it? Two facts had been proved. At Leicester, where the experiment had been carried on regardless of expense, it was proved that the deodorizing of sewage by lime would purify water and prevent it becoming a nuisance to the stream. Since then it had been proved that fish flourished there, and the herbage and fruit, which before were poisoned, had now returned to their normal condition. This fact was also apparent, that the products which it had been thought would be sufficient to pay for these works had proved an entire failure; and except for the lime used, which was very useful for the fertilization of land, it had proved utterly useless. The other fact was the experiment at Croydon, which certainly did appear most successful. There the river formerly was polluted by the sewage. A farm of forty acres was then taken; ordinary drains were cut, the sewage was turned into the land before it passed into the river, thus purifying it of its offensive ingredients, and proving of great advantage to the land. Croydon had thus solved the problem extremely well; but how such a system could be applied to London was a problem still unanswered. He described various propositions which had been submitted to the Metropolitan Board of Health, and that they had acted on the opinion of Mr. Rawlinson, the Government engineer and the adviser of the Government, who was of opinion with regard to London, that it could never be made a commercial success, and must end in bankruptcy. Of course in Bath they were more happily placed; they had not to deal with the excretions of 3,000,000 persons, and the experience of Croydon might be applicable to the case of Bath.

THE FRESCOES IN THE HOUSES OF PARLIAMENT.

MR. W. POOLE KING, of Bristol, has read to the British Association a paper on "The premature Decay of the Frescoes in the Houses of Parliament, its cause and remedy." He said: "Having lived for many years upon the Durdham Down limestone, and for a long course of time made observations on the walls built with mortar from this stone, which I understand has been brought from Bristol, and used for the plaster on which the national frescoes have been painted by special recommendation from authority; and having frequently examined those walls, both in and out of doors, I immediately recognised from the description given by Mr. B. Atkinson, in a paper published in the Journal of the Society of Arts, that exactly similar effects were taking place on the walls of the Houses of Parliament to those

which I had been accustomed to see in constant operation. All the beds of Durdham Down limestone are of marine origin, being full of marine shells; and, although in the long lapse of ages since they were deposited, the marine salt, with which the stone must have been saturated, has, for the most part, been washed out, yet still a trace of it remains insensible to an ordinary analysis. It is the general practice to burn this stone into lime with breeze (or cinder, taken from the scavenger's yard), and this breeze always contains sulphur.

"I need hardly say, that in burning, the minute quantity of marine salt in the stone is converted, for the most part, into sulphate of soda, or the salt well known in commerce as Glauber Salt. On most of the walls that grow cold in winter, I have found needle-form crystals, varying from a bloom 1-100th of an inch to needles of 1 inch in length, and in some instances in damp old walls, such as the cloister walls of a cathedral, the crystals stand out to the length of 1¼in. First, I examined these crystals chemically. They were generally composed of sulphate of soda, in rare instances found mixed with nitrate of potash, and sometimes with small quantities of muriate of lime and magnesia. I soon became familiar with these bunches of needle-form crystals, and from their taste and general appearance, could not mistake them. When the weather becomes dry, all these bunches of crystal efflorescence are converted into a loose white powder, much of which drops from the wall, carrying with it shales of plaster, or flakes of paint, or films of whatever material the surface of the wall is covered with. Moisture will condense on the wall, if allowed to grow cold, in damp weather; the white powder is then dissolved, and the liquor, a solution of sulphate of soda, is absorbed by the mortar or plaster. Architects are in the habit of proving the value of the various kinds of stone presented for their use, for the endurance of frost, by a saturated solution of sulphate of soda, similar to this liquor, which on crystallizing, imitates the heaving and splitting action of ice forming from water. Accordingly, this liquor is no sooner absorbed, as the wall dries, than it aggregates into ice-like crystals, and the plaster is disintegrated and heaved by the dynamical force developed in their formation. The plaster having sustained this injury, the salt transforms itself, and shoots out into bunches of needle-form crystals, only to fall again into the terrible white powder, as the air becomes warm and dry. Thus a constant succession goes on of solution and desiccation, with the changes of the weather and temperature; and if the wall be permitted to cool with the frost, the ruin of the plaster is insured. Sulphate of soda exists, not only in Durdham Down limestone, but unfortunately in many other stones; also in much abundance in all the lias mortars, and in London clays. In fact, I doubt if any London wall is entirely free from its presence. We may, therefore, observe this kind of action of destruction going on more or less almost everywhere. A marked instance

of its injurious effect can be seen in the Crystal Palace, where not only the surface of the richly-decorated walls is attacked, but also the plaster-cast statuary suffers, and requires constant renovation. In Rome and Florence, indeed, many frescoes have remained entire, with their colours smooth and in good order, for hundreds of years; but these frescoes are on plaster made from travertino, a limestone of fresh-water formation, free from salt; and the lime has been burnt with wood charcoal, in which there is no sulphur.

"In a late view which I had of the admirable fresco which Mr. Herbert has finished, I found that the robing-room in the House of Lords was kept with a wet floor. If this apartment be ever allowed to grow cold, can we doubt that the fate of this glorious work of art is sealed? Damp will condense in drops on its surface, and be absorbed; and these drops will dissolve whatever trace of sulphate of soda exists in the plaster, or perhaps in the mortar of the wall. The salt will aggregate together (probably by the force of dialysis), then form ice-like crystals, to heave the plaster and show itself in a bloom on the surface of the fresco; and then desiccate into a dry powder, to be re-dissolved by the first moisture which comes over it; and then be reabsorbed again till at last it aggregates into blotches, and the destruction be complete. To preserve this fresco, I should recommend that the robing-room be kept always warm, and as dry as possible, so that the sulphate of soda may not pass into solution and aggregation; and surely such a work of art, of which the nation is so justly proud, is worth the cost of any expense incurred in its preservation. The 'liquid glass process,' I understand, has been tried to secure the preservation of Mr. Herbert's fresco, but I doubt its power to prevent the plaster absorbing any drops of moisture which may form on its surface. Indeed, if there be any soda in the preparation of liquid glass, it may accelerate the work of destruction, for carbonate of soda is almost as efflorescent a salt as sulphate of soda, into which, however, the former is often converted by the sulphurous acid gas seldom absent from London air. I conclude that fresco-painting on freshwater limestone walls, kept constantly warm and dry, will have the best chance of endurance for ages yet to come, for the delight of our remote successors."

MEASUREMENT OF THE CHEMICAL BRIGHTNESS OF VARIOUS PORTIONS OF THE SUN'S DISC.

PROFESSOR ROSCOE'S paper "On the Measurement of various portions of the Sun's Disc," lately read to the Royal Society, is extremely interesting. The chemically active rays decrease in intensity from the centre to the circumference, which the Professor found by exposing a prepared paper in a camera to the action of the sun's picture, and comparing the shade of tint produced thereby at the centre, and at the circumference, with a certain standard. Dr. Woods, however, suggests the plan he described in the *Philosophical Magazine* in July, 1854. It consists in exposing the prepared paper to the sun's picture in the camera for a

period so short that the centre or most active rays only have time to act on it; then, for the next impression, to leave the paper exposed for a somewhat longer time, so that a somewhat larger picture is obtained; and so on, until the entire picture is given. For instance, suppose the sun's picture is divided into zones by concentric circles, and suppose the centre rays could affect the prepared paper in *one* second, the second zone in *two* seconds, the third in *three* seconds, and the circumference in *four*; then, by exposing the paper for these periods of time, a corresponding amount of the disc would be obtained; the size of the impression produced would be in proportion to the time of exposure; and the intensity of the rays from any part of the disc would be more accurately fixed by once getting the *time* required for their action, and more permanently, Dr. Woods imagines, than by the use of the standard tints. This was the plan Dr. Woods adopted in 1854 to show the identity of the sun's action on a photographic surface with that of flame, the centre rays of the latter being also more intense in chemical action than those at the circumference.

"HOW TO WORK WITH THE MICROSCOPE."

A THIRD edition of this very useful volume, by Mr. Beale, has been published, containing more than twice the amount of work in the previous edition: three new chapters, nearly 100 pages, have been introduced; and the number of plates has been increased from 32 to 56. The author's mode of injection and preparation of tissues, carried out by him with the aid of the highest magnifying powers yet made, are, in this volume, for the first time, published. The paper on Photography contains the result of many years' most earnest work. For the engravings, photographic copies have been substituted for the old drawings by hand; and numerous explanatory subjects have been added. In short, this is a sound working book by a laborious worker, and is throughout practically useful. To aid the photographic illustrations, a glass of low magnifying power is attached to the bit of riband, serving as a place-finder, by which the most delicate beauties and articulations of a photograph may be made visible to the eye.

THE WATT AND WEDGWOOD PHOTOGRAPHS.

THIS interesting subject has been discussed by the Photographic Society of London, but not very favourably to the idea of either Watt or Wedgwood having been a photographer. The photograph found by Miss Meteyard amongst Josiah Wedgwood's papers has, strangely enough, been confronted with one "from the same negative," which was exhibited by Mr. Malone as having been "taken by Mr. Fox Talbot about the year 1843;" and it could not have been among the earliest of Mr. Fox Talbot's photographs, for he himself showed the writer of this one at Glasgow at an earlier date than 1843. How the photograph in question came to be amongst the Wedgwood papers has not yet been ascertained; but it seems that these papers have *not* been locked up

for fifty years—so Mr. Bolton says. As to the large "photographs," though peculiar, they are regarded as specimens of printing in colours. One of the silvered copper-plates has been pronounced by Messrs. Hughes and Kimber, the copper-plate manufacturers, to be only about twenty-four years old. It is a curious fact, however, that it has been ascertained that a person named Daguerre was Wedgwood's agent for the sale of his pottery in Paris. It seems to be believed that the Lunar Society, of which Watt was a member, were engaged in photographic experiments, so that there is still some mystery in the whole affair.—*Builder*. (For the details of the reputed discovery, see *Year-Book of Facts*, 1864, pp. 219-222.)

PROGRESS OF PHOTOGRAPHY.

Wothlytype.—A new process, which has been discovered in Germany by Herr Wothly, and from him has been named "Wothlytype," discards nitrate of silver, and discards albumen. For the former it uses a double salt of uranium, the name of which is at present kept secret; for the latter it uses collodion. By the ordinary method the paper to be printed is sized with albumen, and the surface of the albumen receives the silver preparation, which is sensitive to the light, and shows the printed image. The paper thus does not receive the image, but is, as it were, a mere bed on which lies the material that does receive it. By the substitution of collodion for albumen a different result is reached. In the first place, the film of collodion on the paper yields a beautiful smooth surface on which to receive the image, and the result is that pictures are printed upon it with wonderful delicacy. In the second place, the collodion before it is washed upon the paper is rendered sensitive by being combined with the salt of uranium. The sensitiveness, therefore, is not on the surface alone of the collodion film, it is in the film itself, and so completely passes through it that even if it be peeled away from the paper the image which it received will be found on the paper beneath. The vehicle thus employed is not less superior to all others yet known for printing the positive image on paper than it is to all others yet known for receiving the negative image on glass. The metallic salt which combines with it has also rare merits. In the first place, the manipulations are very simple and easy—far more so than in the silver-printing process, and thus the labour saved is considerable. Next, the paper, when rendered sensitive for printing, or "sensitized," as the photographers say, keeps perfectly for two or even three weeks —an immense boon to amateurs, who can thus have their stock of printing paper "sensitized" for them; whereas at present, when the paper receives the sensitive preparation, it has to be used almost immediately, and will not keep more than a day or two. Thirdly, the colour and tone obtained are very various, including every shade that can be got by the ordinary silver plan; but, in addition, it has the advantage of being able to print any number of impressions of exactly the same colour, and of doing

away with all such difficulties as show themselves in mealiness and irregular toning. The precision of result is a great point. By the silver process the results are never certain, and even when a print comes out perfect from the frame, the subsequent process of washing and fixing go seriously to alter it. Lastly, the permanent character of the new method is very remarkable. Nobody seems to know exactly why the old silver process gives way—whether it be on account of the albumen, or the nitrate of silver, or the hyposulphite of soda. We only know that so many of the prints prepared by the old method fall away that no reliance can be placed in those which seem to stand firm. We know how apt silver is to tarnish, and especially in atmospheres that abound in the compounds of sulphur. Some photographers seem to think that it is this sulphur which does havoc to their labours. Whatever it be, ordinary photographs fade or darken, or in some way alter, and give us little hope of the fixity of those which still hold good. If it is the sulphur of the atmosphere or the albumen that does the mischief, then this which tells so much upon silver has no effect upon uranium; and the images pictured on paper prepared with uranium and collodion give every prospect of lasting as long as the material holds together. These pictures have been exposed to sun and rain for weeks together, and give no sign of alteration. Water seems to have no effect. The process has been purchased from its German inventor by a photographic company, of which Colonel Stuart Wortley is the chairman. Colonel Stuart Wortley has long been known as one of our foremost amateur photographers. Some of his instantaneous pictures, especially his pictures of clouds, are among the finest things yet achieved in photography.—*Times, abridged*.

Quantitative Photography.—Professor Roscoe, in a paper read to the British Association, said:—The theory of the photographic processes having been hitherto in the first or qualitative stage, he had undertaken a series of experiments for the establishment of a Quantitative Photography, the method being based upon the experimental law, discovered by Professor Bunsen and himself, by virtue of which a constant product of the intensities of the acting light, with the times of exposure, always corresponded to a constant tint on the photographic paper. Hence, if several prepared papers were exposed to a constant light for varying periods of time, in order that they should all exhibit the same degree of tint, the reciprocals of these times of exposure represent the relative sensitiveness of the papers. By the help of the pendulum photometer, the times during which the papers had been exposed were ascertained, and the degree of tint attained was read off by the soda light. Tables were constructed showing the variation in sensitiveness produced by increasing the strength of the solution of salts employed, and curves drawn representing this relation. The salts used were chloride of sodium, chloride of potassium, chloride of ammonium, and bromide of potassium. The next point ascertained was the fact that the sensitiveness of the paper did not

vary with variation of the base with which the chlorine or bromine was combined. The third portion of the experiment referred to the comparison of the relative sensitiveness of various salts; a comparison of the sensitiveness of the chloride, bromide, and sodide, and mixtures of these. Professor Roscoe concluded by expressing his intention of continuing these experiments.

Photography on Ivory has not been successful hitherto, it is said, on account of the injurious action of the nitrate of silver. This evil, however, is stated to have been prevented by Mr. Lawrence, an American, by dipping the Ivory, after it has received the image, in a solution of oxalate of peroxide of iron and oxalate of ammonia several times in a dark place, and then allowing it to dry. The plate is next put into a bath of red prussiate and oxalic acid, and after that washed in pure water. When it is dry, the excess of the oxalates of iron and ammonia is brushed away. If the image be too intense, the plate is plunged into a weak solution of cyanide of potassium until the image has acquired the suitable tone. The author of the process states that the image thus obtained presents an excellent surface for miniature-painting.

Instantaneous Photography. — The *American Journal of Photography* suggests this improved practice with regard to Lighting. "Let it well be appreciated that the chemical process remaining the same, the time of exposure is rigidly proportioned to the amount of light. If it now requires ten seconds of exposure for a negative, and a babe can remain still but five seconds, you have only to get twice as much light, and your negative is made in five seconds. All artists of course understand that by removing the stops from the lenses, the light is proportionally increased, but at the great expense of definition; this plan should not be resorted to, therefore, except when other expedients are unavailable. Increase the light falling on the model, should be the maxim. In direct sunlight, portraits are made almost instantaneously; this is a capital fact—but how to make it serviceable is the question. If the direct sunlight be filtered through a pure blue medium, you eliminate everything which is obnoxious, while the unadulterated actinic force is left to do its work. Light is wanted, the more the better; then give it a chance to enter. Skylights facing the north, to avoid the beaming face of our best friend, are unkind and absurd. These thoughts are reasonable, and they are not an untried theory. Mr. Bogardus has lately constructed a camera-room, which we propose to the profession as a model, where the correctness of the system of direct sunlighting is demonstrated; the light looks towards the south, the sitter in a mild twilight is face to face with the sun; Mr. Bogardus often gets the very best negatives in a fraction of a second."

Magnesium Light.—Professor Roscoe, having exhibited to the Manchester Literary and Philosophical Society this new light, emitted by burning a portion of a fine specimen of pure magnesium wire, 1 ^{mm}. in diameter and 10 ft. long, which had been manufactured by Mr. Sonstadt, expressed his opinion that, even for photographic purposes, the application of the metal will prove most important. Mr. Brothers, Mr. Parry, and other photographers present, corroborated Dr. Roscoe's opinion respecting the value of such a source of light for photography. Subsequent to the meeting, Mr. Brothers made an experiment upon the magnesium light, while he reports as follows—"The result of an experiment I have just tried is that in 50 seconds with the magnesium light I have obtained a good negative copy of an engraving, the copy being made in a darkened room. Another copy was made in the usual way in daylight, and in 50 seconds the result was about equal to the negative taken by the artificial light. The sun was shining, but there was a good deal of fog in the atmosphere. (See "Magnesium and its Light," pp. 196, 197.)

Photo-sculpture.—An ingenious application of photography is made in Paris by M. Willème. By this process busts and statues of living persons are prepared in plaster and "biscuit," which possess much of that faithfulness and minute accuracy of detail which are so striking in photographic portraits. The principle of the new art is easily explained. The person whose bust or statue is to be taken is placed in the centre of a circular apartment 40 ft. in diameter, and 24 cameræ obscuræ are placed along the wall at equal distances from him and from each other. By means of a latch, which raises and drops the slides at the same moment, 24 photographs are taken at the same instant of the sitter. He is thus represented from 24 points of view. There are of course six front views, six back views, and 12 side views, so that a clever artist would find in these photographs all the materials for a piece of sculpture to be fashioned by the eye. But this is not the course taken, mechanical processes being adopted which insure much greater accuracy. The negative of one of the portraits is placed in a magic lantern, and the image printed upon it is projected on a large sheet of rough glass. The block of clay in which the model is to be cut is then placed on a revolving stand, the circumference of which is divided into 24 parts. A pantograph is next employed by which the clay is cut exactly to represent the outline on the glass. When one photograph has been copied, the image of the next is placed in the lantern, and the clay is turned round 1-24th part of a circle. It is then copied, and so on with the 24 negatives. The result is that the block of clay exhibits 24 sides or facets, representing exactly the outlines of the 24 photographs. Of course there are ridges left which must be smoothed down, and this process is intrusted to skilful artists. M. Claudet has on exhibition at his gallery in Regent-street a large collection of full-sized medallions, small busts, and statuettes, prepared in this way.

Natural History.

ZOOLOGY.

PUBLIC MUSEUMS—ACCLIMATIZATION OF ANIMALS.

Dr. J. E. Gray, in his inaugural address to the Section of Zoology and Botany at the British Association meeting, has made some valuable observations upon the means for the better arrangement of Public Museums. We have not space for the details, but quote Dr. Gray's conclusion, that "the opinion is rapidly gaining ground, that the scientific student would find a collection solely devoted to study, and preserved in boxes and drawers, far more useful and available for scientific purposes than the stuffed specimens at present arranged in galleries of immense extent, and crowded with curious and bewildered spectators; while, on the other hand, the general public would infinitely better understand, and consequently more justly appreciate, a well-chosen and well-exhibited selection of a limited number of specimens, carefully arranged to exhibit special objects of general interest, and to afford a complete series of elementary instruction, than miles of glass cases containing thousands upon thousands of specimens, all exhibited in a uniform manner, and placed like soldiers at a review."

Dr. Gray then remarks upon the Acclimatization of Animals, which has become a favourite subject with the more thoughtful student, as well as with the public: "Acclimatization, especially the introduction and cultivation of fish, was among the peculiar objects put forward by the Zoological Society at the time of its foundation nearly forty years ago; although, as we all know, it has been able to do very little for its promotion. Scientific zoologists are thought to be opposed to these views, or at least lukewarm on the subject. But (says Dr. Gray) I am convinced that they are totally mistaken in such a notion; and that it can only have originated in the expression of a belief, founded on experience, that some of the schemes of the would-be acclimatizers are incapable of being carried out, and would never have been suggested if their promoters had been better acquainted with the habits and manners of the animals on which the experiments are proposed to be made. With other members of the British Association, I have received a reprint of the Rules of Nomenclature drawn up by Mr. Strickland and others, and printed in the Report of the Twelfth Meeting of the Association (1842), accompanied with a request to examine them carefully, and to communicate any suggestions to Sir W. Jardine, Bart. I can only repeat the suggestion I made when the rules were under the consideration of the Committee of the Natural History Section at Manchester—viz., that the term *acclimatization* has been employed in several widely different senses: first, as indicating the *domestication* of animals now only known in the wild state; secondly, to express the *introduction* of the domesticated animals of one country into another; and thirdly, the *cultivation* of fishes, &c., by the re-stocking of rivers, the colonization of ponds, or the renovation of worn-out oyster or pearl fisheries by fresh supplies."

POLYMORPHISM.

Mr. A. R. Wallace has exhibited to the Entomological Society two boxes of butterflies to illustrate his views on "Polymorphism." He remarked that under the common term "variety" many distinct phenomena were confounded, and proposed to confine that term to those cases in which there was indefiniteness and irregularity in the variation; where a so-called variety kept distinct from the parent stock and propagated itself independently, he would apply the term "local form" or "race." The specimens of Papilio exhibited showed another very remarkable form of variation. In *P. Memnon* the male was in each locality constant; it had rounded hind wings, and was always nearly black, with a few ashy rays; the female, however, existed under two distinct forms; the first had wings shaped like the male, but with a very different coloration, being more or less olive-coloured, and often banded on the hind wings with whitish-yellow, and with marginal black spots. The second form of the female had the hind wings produced into a large spatulate tail, and marked with white patches radiating from the base. Both these forms exhibited varieties in the same locality, but there were no connecting links between them. The males paired with both forms of female, and in each case the resulting brood assumed the forms above described. *Papilio Paramon* was a parallel case, but here there were not only two forms of female differing from the male, but a third, which closely resembled it. In *Papilio Ormenus* three forms of female were found, all differing greatly from the male. The phenomena exhibited by these insects might be paralleled by supposing the discovery of an island inhabited by white men, and black, red, and yellow women, and in which the union of these varied parents produced children which always resembled one or other of the above forms, no intermediate forms ever occurring; the boys being always white, but the girls black, red, or yellow, without any necessary connexion with the colour of their mother, so that, for instance, a black girl might be the offspring of a white father and either a black, red, or yellow mother.—*See the Transactions of the Linnæan Society.*

DECAY OF SPECIES.

Dr. Daubeny has read to the British Association a paper "On the Decay of Species, and the Natural Provision for extending their Duration." The author said it may be assumed as an acknowledged fact, not only that every organized being has a limit

to his existence, but also that the species themselves, both in the animal and vegetable kingdoms, wear out after a certain period. But it still remains to be inquired whether there are not certain natural contrivances for postponing this inevitable termination to a later period than would otherwise happen. Confining himself to the vegetable kingdom, Dr. Daubeny suggested that one of these provisions would seem to be the introduction of new varieties, which, by diverging somewhat from the original type, acquire fresh vigour, and thereby tend to prolong the existence of the species from which they are derived. One of the modes by which this variation in character is secured, follows as a consequence from the mode by which plants are reproduced through the instrumentality of the floral organs; by the concurrent action of which an individual, intermediate in character between its respective parents, and therefore slightly divergent from both, is the result: so that this mode of multiplying the individuals of a species seems to fulfil an important end, even in cases where, as in plants of low organization, the increase of the species is sufficiently provided for by means of buds. Accordingly, plants propagated by cuttings seemed in general to adhere very uniformly to the same type, and to be more limited in their deviation than those produced from seeds. But this deviation from the permanent type was still more completely carried out where the pollen of one plant is made to act upon the embryo of another; and here, perhaps, may arise those numerous contrivances to prevent self-fertilization which Mr. Darwin and others have pointed out. To the same cause, perhaps, was owing the increased vigour which a plant obtains by the removal into a fresh locality or into a deserted country. Many, no doubt, might regard it as a sufficient explanation of these facts, to appeal to the changes produced in the constitution of a plant by such causes as tending to multiply the chances of some members of the species becoming adapted to the changes in the external conditions which occur in the course of time, and which might otherwise have proved fatal to its continued existence. There were, however, reasons for believing that this solution did not embrace all the facts of the case, and that, even where every facility for producing the utmost amount of variation of which the species was susceptible existed, a period at length arrived when a species dies out, although the climate, soil, and other external conditions continue, so far as we could perceive, propitious.

REPLACEMENT OF SPECIES.

The Replacement of Species in the Colonies and elsewhere is the subject of the following note by Dr. J. D. Hooker, in the *Natural History Review*:—

"We learn that in Australia and New Zealand the noisy train of English emigration is not more surely doing its work than the stealthy tide of English weeds, which are creeping over the waste and cultivated virgin soil in annually

increasing numbers of genera, species, and individuals. Cow-grass, dock, sow-thistle, watercress, &c., grow everywhere; and the young native vegetation appears to shrink from competition with the vigorous intruders. The rapid propagation of European animals is no less remarkable. Mr. J. Haast, the Government geologist at Canterbury, in New Zealand, has written to Mr. Darwin as follows:—'The native (Maori) saying is, "as the white man's rat has driven away the native rat, so the European fly drives away our own, and the clover kills our fern, so will the Maoris disappear before the white man himself." It is wonderful to behold the botanical and zoological changes which have taken place since first Captain Cook set foot in New Zealand. Some pigs, which he and other navigators left with the natives, have increased and run wild in such a way that it is impossible to destroy them. There are large tracts of country where they reign supreme. The soil looks as if ploughed by their burrowing. Some station-holders of 100,000 acres have had to make contracts for killing them at sixpence per tail, and as many as 22,000 on a single run have been killed by adventurous parties without any diminution being discernible. Not only are they obnoxious by occupying the ground which the sheep-farmer needs for his flocks, but they assiduously follow the ewes when lambing, and devour the poor lambs as soon as they make their appearance. They do not exist on the western side of the Alps, and only on the lower grounds on the eastern side, where snow seldom falls, so that the explorer has not the advantage of profiting by their existence where food is scarcest. The boars are sometimes very large, covered by long, black bristles, and have enormous tusks, resembling closely the wild boar of the Ardennes, and they are equally savage and courageous. Another interesting fact is the appearance of the Norwegian rat. It has thoroughly extirpated the native rat, and is to be found everywhere, even in the very heart of the Alps, growing to a very large size. The European mouse follows it closely, and, what is more surprising, where it makes its appearance, it drives, to a great degree, the Norway rat away. Amongst other quadrupeds, cattle, dogs, and cats are found in a wild state, but not abundantly. The European house-fly is another importation. When it arrives it repels the bluebottle of New Zealand, which seems to shun its company. But the spread of the European insect goes on very slowly, so that settlers, knowing its utility, have carried it in boxes and bottles to their new inland stations.'"

SUGAR IN CORPULENCY.

In connexion with the dietary system adopted by Mr. Banting for the reduction of corpulency, whether, as affirmed, sugar is a food which, above others, adds to the bulk of the body, and should be avoided in cases of obesity, has been much controverted. In proof, it has been stated that one person gained 1 lb. in weight in one week from the use of 7oz. loaf-sugar, and another 14 lb. in six weeks from 1½ oz. sugar per day. It has long been known and admitted that sugar is a fattening substance when taken in a quantity exceeding the daily requirements of the body; but a Correspondent of the *Times* impugns the above relation of increase to weight which has been attributed to sugar.

"As to the composition of sugar" (says the writer in the *Times*), "if all the sugar which your Correspondents ate had been converted into fat, it could not have produced the increase of weight referred to, for 7 oz. would be equal to only about 3 oz. of fat, and 63 oz. to a little more than 1½ lb. of fat; while the increase of weight is stated to have been five times and nine times greater than these quantities; but it is quite certain that some or all of the sugar was consumed by the body at the time when it was taken, and hence the portions, if any, which were left to form fat must have produced less than the amounts above mentioned. As to the experiments upon pigs, Messrs. Lawes and Gilbert found that the largest quantity of food was eaten by and the largest increase of weight was found in those which ate mixed starch and

sugar; while the gain in weight was less, but in precisely the same degree, when sugar was given alone as when starch was given alone. Hence it was proved that the fattening properties of sugar and starch were precisely the same; and the greater increase of weight which occurred with the sugar and starch combined was due to the increased quantity of food which the variety tempted the animal to take, and not to the sugar alone. Whatever, therefore, may be the effect of sugar in increasing weight, the same effect can be produced from starch or from about 1¼ times its weight of wheaten flour; and as sugar is a far more costly substance than starch, any attempts by agriculturists to fatten animals upon it must be attended by serious loss. I will not cite the experiments Majendie made many years ago, and will only add from my own, that of all substances which are taken as food, none are so quickly destroyed and resolved into other elements as sugar, for within a few minutes after it had been taken the products of respiration were largely increased. This, so far, is opposed to the statement of the fattening results of sugar-eating."

The writer then adds a few words in reference to the weight of the body, and the mode of taking it, and the natural variations in it. As to the uniformity of the weight of the body for weeks together, he shows this assumption to be very fallacious:—

"The body is 1lb. to 2lb. heavier after a meal, 1lb. to 2lb. lighter after egestion, 1lb. to 2lb. heavier at night, and 1lb. to 2lb. lighter after the night's absence of food. If the person perform much physical labour and live regularly during the week, and rest entirely on the Sunday, he is 1lb. to 4lb. heavier on the Monday than on the Saturday. On the occurrence of a sudden thaw his hands swell, fluids are retained, and he becomes heavier, and on the sudden occurrence of a cold wind or a frost, his egestion is increased and he becomes lighter. I have lost 4lb. weight in one day from this cause alone. In spring a person gains, and in a hot summer he loses weight. Such are natural variations in weight, and it may be added that they are the most marked in persons given to obesity, and as I am of that class, the following statement of my net weight daily for a month, with the ordinary regularity in food, may be interesting. The weights are the mean of the observations made at night and the following morning, and they are in addition to an uniform weight of 13 stone:—

	Week ending							
	Feb. 10.		Feb. 17.		Feb. 24.		March 3.	
	lb.	oz.	lb.	oz.	lb.	oz.	lb.	oz.
Sunday	—		9	14	9	3	11	1¼
Monday	9	6½	7	10	9	2	9	13
Tuesday	9	7¼	8	7½	10	7¼	9	9
Wednesday	9	2	7	12½	9	12½	11	2
Thursday	8	2¼	8	6¾	8	2½	10	4¼
Friday	8	8	8	8¼	8	14	—	
Saturday	8	8	7	8	8	14¼	9	15

To all these causes of variation must be added the effect of varying quantities and qualities of food, for no one eats precisely the same quantity and quality daily, and yet he may not be aware of it."

The writer, however, dwells more particularly upon the erroneous assumption that the increase of weight is due to sugar, and adds with some authority—"no inquiry is so complex as that into the action of any agent over the body when the experiment is continued for some weeks, and none therefore in which it is so difficult to connect the cause and the effect."

To this letter Mr. Banting, who rigorously eschews sugar, has replied, as "one good authority against another, without entering into the physiological reasons for either."

LETHARGIC SLUMBER.

A PAPER has been communicated to the French Academy of Sciences by Dr. Blanchet on three curious cases of constitutional Lethargic Slumber. One of them was that of a lady 24 years of age, who having slept for 40 days at the age of 18, and 50 days at the age of 20, during her honeymoon, at length had a fit of sleep which lasted nearly a whole year, from Easter Sunday, 1862, to March, 1863. During this long period a false front tooth had to be taken out in order to introduce milk and broth into her mouth. This was her only food; she remained motionless, insensible, and all her muscles were in a state of contraction. Her pulse was low, her breathing scarcely perceptible; there were no evacuations, no leanness; her complexion was florid and healthy. The other cases were exactly similar. Dr. Blanchet is of opinion that in such cases no stimulants or forced motion ought to be employed.

PHYSIOLOGICAL EFFECTS OF TOBACCO.

DR. RICHARDSON has read to the British Association an inquiry upon this subject, which he concluded with the following summary:—

1. The effects that result from Smoking are due to different agents imbibed by the smoker: viz., carbonic acid, ammonia, nicotine, a volatile empyreumatic substance, and a bitter extract. The more common effects are traceable to the carbonic acid and ammonia; the rarer and more severe to the nicotine, the empyreumatic substance, and the extract. 2. The effects produced are very transitory, the poisons finding a ready exit from the body. 3. All the evils of smoking are functional in character, and no confirmed smoker can ever be said, so long as he indulges in the habit, to be well; it does not follow, however, that he is becoming the subject of organic and fatal disease because he smokes. 4. Smoking produces disturbances: (*a*) in the blood, causing undue fluidity, and change in the red corpuscles: (*b*) on the stomach, giving rise to debility, nausea, and, in extreme cases, sickness: (*c*) on the heart, producing debility of that organ, and irregular action: (*d*) on the organs of sense, causing in the extreme degree dilatation of the pupils of the eye, confusion of vision, bright lines, luminous or cobweb specks, and long retention of images on the retina; with other and analogous symptoms affecting the ear, viz., inability clearly to define sounds, and the annoyance of a sharp ringing sound like a whistle or a bell: (*e*) on the brain, suspending the waste of that organ, and oppressing it if it be duly nourished, but soothing it if it be exhausted: (*f*) on the nervous filaments and sympathetic or organic nerves, leading to deficient power in them, and to over-secretion in those surfaces—glands—over which the nerves exert a controlling force: (*g*) on the *mucous membrane* of the mouth, causing enlargement and soreness of the tonsils—smoker's sore throat—redness, dryness, and occasional peeling off of the membrane, and either unnatural firmness or contraction, and sponginess of the gums: (*h*) on the *bronchial surface of the lungs* when that is already irritable, sustaining the irritation, and increasing the cough. 5. The statements to the effect that tobacco smoke causes specific diseases, such as insanity, epilepsy, St. Vitus' dance, apoplexy, organic diseases of the heart, cancer and consumption, and chronic bronchitis, have been made without any sufficient evidence or reference to facts; all such statements are devoid of truth, and can never accomplish the object which those who offer them have in view. 6. As the human body is maintained alive and in full vigour by its capacity, within certain well-defined limits to absorb and apply oxygen; as the process of oxydation is most active and most required in those periods of life when the structures of the body are attaining their full development; and, as tobacco-

smoke possesses the power of arresting such oxydation, the habit of smoking is most deleterious to the young, causing in them impairment of growth, premature manhood, and physical degradation.

If the views thus epitomised, in relation to the influence of tobacco-smoking on individuals, be true, it is fair to say that, in the main, smoking is a luxury which any nation of natural habits would be better without. Dr. Richardson, putting down the number of smokers in Great Britain at a million, maintains that they are not in perfect health from day to day; but are living with stomachs that only partially digest, hearts that beat unnaturally, and blood that is not fully oxydized.

THE WHALEBONE WHALE.

DR. J. E. GRAY's notes on the Whalebone Whale (Mysticete), with a synopsis of the species, appear in the *Annals of Natural History* for November. Little is known of these whales and their structure, in consequence of the rarity of their occurrence and the difficulty of examining them and comparing the parts in detail; hence various species have been frequently confounded. The study of the subject, and especially of the bones that have been collected, has led Dr. Gray to the following conclusions:—Though the adult whalebone whales have a large head compared with the size of the body, the head of the fœtal specimen is short, and increases in size, and especially in length, much more rapidly than the rest of the body. This is very apparent in the Right or Greenland whale, where the head of the adult is two-fifths, while that of the new-born is only two-sevenths of the entire length of the animal. The bones of the whalebone whales in the very young state are the same in number, and nearly the same in form, as in the adult animal; the bones only becoming more or less completely ossified, which they appear to do very slowly, and in some species even more slowly than in others; so that the notion that the number of vertebræ increases with the growth of the animal, which has been entertained by some naturalists, is a mistake. It also appears that certain parts which become ossified in most kinds of whalebone whales do not become so in others. The general form of the baleen, the comparative thickness of the enamel, and the fineness or coarseness of the internal fibres which form the marginal fringe, and the internal structure as shown by the microscope, all present good characters for determining the species and for separating the whalebone whales into natural groups. The difference in form of the tympanic bones is great, and affords good characters, not only to separate the species from one another, but also to group them into families and genera. The whalebone whales are characterized by having only very rudimentary teeth that never cut the gum, and by having cross rows of flexible horny plates, fringed on the inner edge, on each side of the palate. The tympanic bones are large, couch-like, and attached to the expanded periostic bones, which are articulated to the skull. The lachrymal and malar

bones are small and thin, and are often lost in preparing the skulls.

As the *Alexander*, belonging to Dundee, was steaming about in Davis's Straits, on the 24th September, a large whale, of about 12 tuns, was observed not far distant from her. Boats were immediately put out, and the crew succeeded in securing the animal. When the crew came to flense the fish, they were astonished to find embedded in its body, two or three inches beneath the skin, a large piece of a harpoon, about 18 inches long. On one side of it were engraved the words "Traveller, Peterhead," and on the other "1838." This vessel was lost about eight years ago in the Cumberland Straits when prosecuting the whale-fishery there; and it is therefore clear that the harpoon must have remained in the animal for that time at least.

DESTRUCTIVE ANIMALS IN FRANCE.

A CURIOUS document has been published, giving a list of the Ravenous and Destructive Animals destroyed in 1863 by the keepers in the forest of Compiègne. The total number killed by gun or traps amount to 10,931: consisting of 93 foxes, 5 badgers, 181 polecats, 533 wild cats, 1797 weasels, 537 hedgehogs, 1043 buzzards, hawks, falcons, and vultures; 1701 owls of different kinds, 1726 magpies, 1639 ravens, and 1675 jays. The expense incurred for this destruction amounted to 3324f.

OURANG AND CHIMPANZEE IN THE ZOOLOGICAL SOCIETY'S GARDENS.

THE new monkey-house lately erected by the Zoological Society in their Gardens in Regent's Park now contains specimens of both of the best known species of apes usually called "Anthropoid," from their resemblance to mankind. These are the Ourang (*Simia satyrus* of naturalists) and the Chimpanzee (*Troglodytes niger*), which are now exhibited together in one compartment of the Society's monkey-house. The following are the descriptive details of these interesting specimens.

The ourang is a young female about four years old, as near as can be guessed. It was received from Borneo in May last, and has thriven well during the time it has been in the Society's possession. In its native state the ourang is only found in Borneo and certain parts of Sumatra, inhabiting the low, flat plains of these islands, where the forests are densest and most sombre. Those of our readers who are interested in the habits of this ape in its native wilds should consult Mr. Wallace's article on this subject in the *Annals of Natural History* for 1856, where ample details, derived from this naturalist's personal experience, will be found.

The chimpanzee, also a young female, probably not so far advanced in years as her companion the ourang, was brought from the West Coast of Africa, and purchased at Liverpool for the

Society by the Superintendent of the Gardens, who was despatched to secure the prize upon its arrival.

It has been stated that the ourang and chimpanzee had never before been exhibited together; but this, we believe, is not strictly correct, although it is many years ago since this has been the case. In 1831, as we learn from a pamphlet on the subject, which is ornamented with portraits of the animals by Thomas Landseer, two so-called "orang-utans" were exhibited at the Egyptian Hall, Piccadilly, one of which, from the details given, appears to have been, without doubt, a chimpanzee. This fact, however, it may be supposed, will scarcely prove any detraction from the interest excited by the present pair of Anthropoids.—*Illustrated London News* (where the portraits of the animals are engraved).

THE ANCIENT AND MODERN HYÆNA.

M. A. Gandry states there to be three recent species of Hyæna—the spotted, the striped or common, and the brown; the first two differing so much in their dentition as to lead many naturalists to consider the spotted hyæna to be a sub-genus, under the name of *crocuta*. M. Gandry is acquainted with several fossil hyænas, one of which, the Hyène de Montpellier, is so closely allied to the recent common hyæna, that it is not unreasonable to admit their specific identity; another, the cave hyæna, is closely allied to the recent spotted hyæna; and finally, the hyæna of Pinkeroni enters into the group of the brown hyæna, and is still more intermediate between the spotted and common than that species. The magnificent head of *Hyæna brevirostris*, found near Puy, by M. Aimard, presents the same peculiarities of its dental arrangement as the Grecian species.

NEW BIRDS.

Megapodius Pritchardii, a new species, twelve to thirteen inches long, is described by Mr. G. R. Gray in the *Proceedings of the Zoological Society*, from a specimen sent to him by Mr. W. T. Pritchard, who obtained it at Nina Fou, which island is situated about half way between the Feejee Islands and the Samoan Islands, and is far removed to the northward of the Friendly or Tonga Islands, yet it is considered to form part of this latter group. The natives informed Mr. Pritchard that the bird laid "200 eggs, and piled them one above another in the shape of a pyramid, the last egg forming the apex." This statement he hesitated to believe; but the natives reiterated it. The bird lives in the bush, runs very fast, and does not fly any distance at a time. The Nina Fou bird was lately recorded in the *Proceedings of the Society*, from information obtained by Mr. Bennett of Captain M'Leod, who stated that the bird was known to the natives by the name of "mallow," and that it lives in the scrubs in the centre of the island, about the margin of a large lagoon of brackish water, which has the appearance of having been an extinct crater. The birds lay their eggs on one side only of the lagoon, where the soil is composed of sulphur-looking sand; the eggs are deposited from one to two feet beneath the surface. This latter account is in accordance with the known habits of several of the species of this genus, and Mr. Gray says that Mr. Pritchard was right in doubting the correctness of this marvellous and most improbable story related to him by the natives. It is only by the permission of the king or chief that the eggs or birds can be procured, which is also the case in other localities. There is in the British Museum an egg, with the provisional name of *Megapodius Burnabyi*, which agrees with the description of the Nina Fou egg. It was obtained by Lieut. Burnaby, R.N., at the Hapace Islands, which is the centre clustre of the three groups usually considered to form the Friendly or Tonga Islands. The bird of the Hapace Islands may, when made known, prove to be a species closely allied to the *Megapodius Pritchardii*, if not the same.

OSTRICH FARMING.

The *Cape Argus* publishes the following statement taken from a Colesberg paper:—"At a meeting of the Committee of the Agricultural Society, Mr. L. von Maltitz has given the following account of his experience in Ostrich Farming:—'Towards the close of last year I purchased 17 young ostriches of three or four months old. I placed them in an enclosure of 300 acres in extent, in which they had a free run. They have been kept there ever since, and have subsisted entirely upon the herbage of the enclosure, except an occasional feed of grain when driven up to the house for the inspection of visitors. I had other stock within the enclosure, and 35 birds can be carried year in and year out upon 300 acres of good grazing land,—land rather superior to the common run. At the end of April I had the wings of the birds plucked, where the feathers of commerce grow. In consequence of the youth of the birds, these feathers were valueless. I now find that the birds will be fit to pluck again at the end of the present month, verifying the statement made at the last Swellendam show by one of its members, who was, like myself, experimenting in this novel description of farming, that he obtained feathers fully grown from his ostriches every six months. My ostriches are so tame that they allow themselves to be handled and their plumage minutely examined. Being desirous of ascertaining the opinion of those versed in the trade as to the commercial value of the feathers, I have had the birds examined by several, and the general opinion is that the largest feathers, of which there are 24 on the wing of each male bird, are worth 25*l.* per lb., and that the yield of the whole plucking, the majority of the birds being males, will not fall short of 10*l.* each upon the average. I think the statement made at the Swellendam Agricultural Show sets the value of each half-yearly plucking at 12*l.* 10s. per bird; and this

I have no doubt will be the average of mine when they arrive at maturity, according to the present market-value of feathers. The original cost of the young birds was about 5*l*. each.' It seems to us by the foregoing that our hither neglected district, which, with the adjoining Free State, is pre-eminently the ostrich country, is likely to eclipse the gold mines of Australia, California, and Vancouver."

WILD GEESE—WINTER OF 1864.

THE Rev. F. O. Morris writes from Nunburnholme, Yorkshire, Dec. 6, as follows:—"This season, for the first time since I have lived here, I have missed seeing the flocks of Wild Geese which in the autumnal months have heretofore wended their way overhead, year after year, as regularly as the dusk of the evening came on. Almost to the minute, and almost in the same exact course, they have flown over aloft from their feeding-places on the Wolds to their resting-places for the night; some, perhaps, to extensive commons, while others have turned off to the mud-banks of the Humber, whence they have returned with equal regularity in the morning.

"But this year I have seen not only not a single flock, but not even a single bird. One evening one of my daughters did, indeed, see a small flock of six, but even that small number only once. Whether it portends a very hard winter, or what the cause of it may be, I am utterly at a loss to know, or even to guess. I quite miss this year the well-known cackle of the old gander, as he has led the van of the flock that has followed him, now in a wide, now in a narrow, now in a short, now in a long wedge, overhead, diverging just from the father of the family, or separating from time to time further back in the line.

"There is much to be cleared up in the natural history of the wild geese, as shown in letters I had from the late Mr. Arthur Strickland, of Burlington-quay, the best-informed ornithologist I ever knew.

"I may add, as a possible prognostication of future weather, that fieldfares have, I think, been unusually numerous this year, as last year they were the contrary. Haws, too, are remarkably abundant, some trees being quite a mass of deep red; but this is by no means a certain sign by itself of a hard winter. I also remarked that swallows took their departure this year more than ordinarily in a body, very few stragglers being subsequently seen."

FISH IN THE WELL.

PROFESSOR DÉSOR, of Neufchâtel, the well-known natural philosopher, coming from a prolonged journey in Algiers, writes on board the steamer *Ganges*, in one of his last travelling reports:—

"I have only superficially mentioned one of the most curious phenomena, which may puzzle the natural philosopher; I mean the small Fish which have

shown themselves in several Artesian Wells, at the moment when the column of water rushed up from a depth of fifty metres. The fact is indisputable, although its authenticity has been doubted. I myself have found them in the canal of the well in the Oasis Ain-Tala, the same in which Captain Zickel observed the fish when the water-column first rose over the surface. It is impossible that these fish should come from anywhere else than from out of the well, for the water stands in no communication with either basin or river. The fish belong to the family of carps, and if I am not mistaken, to the proper species of Cyprinodon. I am bringing some with me, and shall put them before the Society of Natural Science, and before some of the ichthyological authorities, Herr von Siebold, for instance. The most curious thing is, that these fish, although coming from the interior of the earth, from a depth of more than 150 feet, have nothing sickly or misshapen about them; they are of a most remarkable liveliness, and, what is especially worthy of note, have fine, large, completely healthy eyes. You know that the fish and other aquatic animals which are found in the subterranean ponds of the Adelsberg Cavern in Steyermark, and in the Mammoth Cavern in Kentucky, are all blind. Their ocular organs are stunted, and often nothing is left of the eye but the optic nerve. Some naturalists, therefore, have tried to classify them as a species of their own, while others, whose opinion I share, maintain that every organ deprived of the opportunity to exercise its functions, must necessarily degenerate at last, and become defective. But here we have a fish from the interior of the earth, with perfect eyes. How are we to account for this? I confess that this phenomenon puzzles me, yet I think I have found the key to the riddle. The subterranean basin, which feeds the Artesian wells, must be of considerable dimensions, as the water springs up on a space of many square miles, wherever it is bored. Besides these artificial wells, there are ponds in several oases, especially that of Urlana, fed by rich sources, and from which real brooks spread in different directions. These ponds harbour the same little Cyprinodonts which rise in the water of the Artesian wells, by which I conclude that a subterranean connexion exists between the ponds and the wells. Probably they visit those ponds periodically, perhaps to spawn; this would explain why their eyes, and their formation in general, show nothing abnormal."—*Athenæum*.

CAPTURE OF A SUN-FISH.

A LARGE specimen of this exceedingly rare fish has been captured off the Start Point by the crew of the yacht *Night Thought*, Mr. J. D. Lee. Attention was first drawn to a huge dark object on the water. On a boat being sent, it was soon discovered to be the back fin of a very large fish, apparently asleep. A very exciting chase commenced, extending over an hour, the crew meanwhile battling with harpoons, boat-hooks, &c., the fish several times trying to upset them by getting his back under the boat. At length, a line was thrown over its head, and the fish being weakened by the struggle, was towed alongside the yacht, hoisted on board and slaughtered. The yacht put into Dartmouth, and the crew sold their prize to Mr. H. Humphreys, of that place. The fish has been preserved by Mr. Henry Nicholls, of Kingsbridge, and exhibited. Yarrell, in his work on British fishes, states, in reference to these fish, that "the largest are about 3 cwt.," but this specimen weighed 6 cwt. Sun-fish are found occasionally in the tropical seas of large dimensions, but those found in the Channel seldom, if ever, exceed from 1 cwt. to 2 cwt. The peculiarities in regard to these fish are, that they have no bones, but the whole of the formation is of cartilage, which can easily be cut with a knife. The skin is cartilage of about an inch

and a half thick, under which there is no backbone or ribs. This specimen is one of extraordinary dimensions, it being 5 ft. 10 in. in length, and 7 ft. from the tip of the dorsal to the point of the anal fin, and weighs, as before stated, about 6 cwt. —*Western Daily Mercury.*

SALMONIDÆ.

Dr. J. Davy has read to the British Association "Some Observations on the Salmonidæ, chiefly relating to their Generative Function." It is now accepted as an established fact that the young of the salmon in its parr stage has, in the instance of the male, the testes fully developed, so as to be capable of impregnating the ova of the adult fish. Remarkable and anomalous as this must be admitted to be, it is the more so, considering that, in the female parr of the same age, the ovaries are merely in their rudimentary state, and are indeed so small, that they may readily escape observation, and give rise to the opinion that the parrs are exclusively males. The author next referred to the time when the salmon and sea-trout begin to breed, and to the question—Do they breed yearly or in alternate years? "The generally received opinion, I believe, is that their fertility is continuous from year to year. From such observations as I have made, I am disposed to doubt the correctness of this conclusion, and to infer that their breeding takes place rather in alternate years, or at least not in successive years."

Sir W. Jardine remarked, "that with regard to the salmon breeding yearly or in alternate years, the number of barren fish occasionally taken was presumptive of their breeding in alternate years. If Dr. Davy would go to the river Tweed in the end of November, and fish with salmon roe (which is now forbidden), he might kill a basket full of the *Salmo croix* all in a fit condition for the table."

PROGRESS OF SALMON-BREEDING ON THE RIVER TAY.

In the *Times*, December 27th, 1864, we read:—"The present is perhaps the best spawning season that has been experienced since the commencement, ten years ago, of the Stormontfield artificial spawning operations. Having visited the ponds on the 22nd of December last, we found that Peter Marshall, the resident pisciculturist, had up to that date deposited in the breeding-boxes more than 300,000 salmon eggs, and that he still had three adult fish to spawn, from which he calculated upon obtaining something like 50,000 additional eggs, and he told us that that number would complete the total quantity required this season—viz., 350,000; indeed, the boxes cannot conveniently hold any more, although another row has been constructed. The additional boxes will admit of the eggs of the three adult fish being yet deposited. The ponds were originally designed with a view to breed no more than 300,000 fish per annum; but, after a trial of two years, it was found, from a speciality in the natural history of the salmon, to be afterwards alluded to, that only half that number of fish could be bred in each year.

"First is chronicled the erection of an additional pond; and, secondly, a plan of confining such old fish, taken from the Tay for the purpose of being artificially spawned, as are not quite matured in the millrace from which the breeding-ponds are supplied with water.

"At the time of our visit one of the ponds (the original one) was swarming with young salmon hatched out in March and April last, the eggs having been placed in the boxes in November and December, 1863. Half of these will be prepared to depart from the ponds as smolts about May next; the other half, we suppose, will be transferred to the new pond, or can remain, as there is direct communication with both of the ponds from the canal at the foot of the suite of breeding boxes which have lately been renewed. The requirements of semi-yearly spawning have not been strictly observed of late years, so that eggs were laid down in both the years 1862 and 1863. In the former of these years the ova laid down was 250,000, and in 1863 about 80,000; indeed, no more could be obtained in consequence of the river being in an unfavourable state for capturing the gravid fish.

"A point pretty well settled by the river Tay experiments is that a smolt of, say, a year old, may go down to the sea and return in a few months as a grilse of four pounds weight, while its brother and sister fish are still tiny parrs of about half an ounce weight! This seems an unexampled ratio of growth, but it has been proved over and over again; none of the pond-bred fish have been marked of late years, however. It has also been proved, we think, that salmon spawn annually. Some of the fish spawned at Stormontfield were marked after they had been used, and were taken again the following year on the same spawning beds. The question was lately asked,—What is a grilse? That problem has also been solved on the river Tay. A grilse is undoubtedly a salmon in a certain stage of its growth. It is called a salmon after it has begun to spawn, and it would be advisable to know clearly at what age this fine fish begins to be reproductive."

Then is briefly recapitulated what has been achieved at Stormontfield. "The stocking of the boxes began on the 23rd of November, 1853, and in the course of a month each of the 300 boxes was filled with 1000 eggs, and the present keeper, Mr. Marshall, appointed to watch over them. On the 31st of the following March (1854), the first egg was seen to be hatched, having taken a period of 128 days to come to life; the rest of the eggs speedily burst, and the young fish came forth in great numbers. About, May, 1855, when the fry were a year old, it became uncertain whether or not they would change into smolts; but the question was shortly settled, for the fish began to change about the end of May, and were in consequence very speedily dismissed

to begin their career in the river and sea. Only a few thousand of fish resulted from the next hatching, in consequence of ignorance displayed in the manipulation of the gravid salmon; we will consequently allow only 5000 for that year. At the end of 1855 the third spawning took place, but only 183 of the boxes were filled, and the eggs in these came to life in 1856, and some of them left the ponds, as smolts, on the 12th of April, 1857. The spawning season began on the 12th of November, 1857, when 150,000 eggs were obtained from a total of 19 fish. These came to life in March, and the hatching proved to be very prolific, as very few of the eggs were addled. The next spawning season was that of 1859, when 250,000 eggs were obtained, and the first of these was observed to burst on the 10th of April, 1860. During all these hatchings the same phenomena of growth were noted, and various plans were hit upon to mark and check the rate of growth of the fish."

Upwards of a million of pond-bred fish have now been thrown into the river Tay, and the result has been a satisfactory rise in the salmon rental of that magnificent stream.

SALMON IN THE THAMES.

MR. FRANK BUCKLAND writes to the *Field*, as follows:—

Mr. Grove, of Charing Cross, has been good enough to let me know he had just received a Salmon of 12½ lb. weight, and in perfect condition, which had been caught the previous night on the Essex-coast, the London side of Southend, by some men who were fishing (I believe for gar-pike). Upon examining the fish, I found it to be in perfect order, but the question at once arose whether it was a grilse or a salmon. My friend Mr. Ffennell, Inspector of Fisheries, happened to come in at the moment, and gave it as his decided opinion that it was a salmon, probably on his second journey to the fresh water from the sea. There is also another question—viz., whether this fish was a salmon wandering about in search of a river to go up, or whether it was a fish bred and turned down by the Thames Angling Preservation Society, for the first young fish was turned out in the spring of 1861, and several thousands have been turned down every year since, so that it is possible, nay, even more than probable, that this Thames fish is one of our own hatching. It will be remembered that some smolts were caught in June last at the mouth of the Thames, and exhibited in Mr. Charles's shop. These smolts last year, and two salmon this year—for this is the second caught at the mouth of the Thames since Christmas—will, I think, go to prove the fact there are really salmon at the mouth of the Thames, and that they would come up if they could. Mr. Grove kindly allowed me to examine the intestines of this salmon. I find it to be a male fish, with the milt very slightly developed. The stomach was filled with that peculiar white cream-like mucus generally found in all salmon. Wishing, however, to ascertain the exact composition of this mucus, I have examined it under the microscope, and find it to contain large numbers of minute transparent bodies which, presenting almost a crystalline appearance, much resemble the *débris* of scales of fish. As I know from experience with the salmon I brought from Worcester to the Zoological-gardens, that salmon will eat small fish, and whereas there are a great number of so-called whitebait about the mouth of the Thames, it at once struck me that this Thames salmon was following up these little fish in order to eat them. I have therefore examined some scales of the whitebait, and compared them with the contents of the salmon's stomach, and I have every reason to believe that the latter is simply an accumulation of the undigested scales and of the pigment-cells which contain the lustrous material whence the whitebait derive their peculiar silver-like appearance.—FRANK BUCKLAND. P.S.—Within the last few days the Society has turned into the Thames no less than 12,040 young salmon the size of minnows, all beautiful, healthy little fish.

FISH-HATCHING.

IN the grounds of Mr. Francis Francis, Twickenham-common, arrangements have been made under the direction of the Acclimatization Society. The work commenced on a very economical scale, the cost of the sheds, tanks, troughs, &c., having been kept within the sum of 120*l*. The apparatus is comparatively simple, consisting of a large cistern, which forms the watershed of several tiny rivulets, flowing gently through a number of stoneware troughs, in which the eggs are placed during the process of maturation and hatching. These troughs are arranged on stages one above the other, in such a way that the water runs out at the bottom of each into the top of the one below it. Each trough is about three feet long by eight or nine inches wide, having a depth of perhaps five inches; and is provided at the surface of the water with a gridiron formed of thin glass rods, placed so closely together, that the eggs, which are the size of a small pea, cannot fall through. As soon as the egg is hatched, the fish passes through the glass bars into the lower part of the trough, from which it is transferred to another series of troughs, containing small stones and pieces of slate; beneath which the young strangers hide themselves until the egg-sac with which they are provided for the nourishment of their early days falls off, and they find themselves obliged to cater on their own account. They are then removed to the rivers which are to form their future home. The operation of placing the eggs in the trough was begun on Christmas Eve, 1863, when over 130,000 were tenderly cared for by Mr. Francis and his able coadjutors, Messrs. James Lowe and Frank Buckland; over 40,000 eggs and fry distributed, and fresh supplies received from the French Acclimatization Society, which has all through acted in the most generous manner to its young English brother. The eggs in the troughs at Twickenham in February were:—Salmon, 6500; salmon trout, 5000; common trout, 67,000; great lake trout, 7500; charr, 4000. The charr mentioned above is the *ombre chevalier* of the Swiss lakes, and is a much finer fish than the English member of the family. Of the 130,000 eggs under culture no more than 4000 or 5000 died; the only condition for keeping them in health appearing to be the constant supply of a gently moving stream of water, and the immediate removal of any dead eggs. The manuals lately published by Messrs. Francis and Buckland render any more lengthened details on the subject of fish-hatching unnecessary. It may, however, be interesting to know that the young fish makes its appearance about six or eight weeks after the fecundation of the egg, about the same time elapsing before it loses its egg-sac. Besides sheds and troughs for the hatching operations, the Society has formed several ponds for the preservation of the fry, and a canal has been cut in connexion

with the river Colne, which runs through Mr. Francis's property, to serve as a dwelling-place for any milting and spawning fish that may be required by the Association.

Mr. Pender, of the Elms, Hampton, has undertaken the fish-hatching for the Thames Angling Preservation Society. In the third year he had hatched a large number of fish in his apparatus, turned many thousand fish into the Thames, the result being that many young trout, salmon, and salmon-trout have been seen and even taken with the fly in the shallows of the river.

SILURUS GLANIS.

An important and, it is expected, highly useful addition has been lately made to our fish tribe, by the importation of fourteen young specimens of the *Silurus glanis*, from Wallachia. The Acclimatization Society is indebted for this valuable acquisition to Sir Stephen Lakeman, who possesses an estate at Kapochein, in Wallachia, where this fish is abundant. The *Silurus glanis* attains a great weight under favourable conditions, thrives in lakes having peaty bottoms, and is remarkable for its delicious flavour.—*Athenæum.*

OYSTER CULTURE.

A very interesting lecture on this subject has been read to the Society of Arts by Mr. James Lowe, joint secretary to the Acclimatization Society of Great Britain. The lecturer commenced by stating that the art of Oyster Culture was by no means a new one, having been carried on with perfect success by the inhabitants of the borders of Lake Fusaro, in Italy, from the time of the Romans to the present day. Fifteen years ago M. de Quatrefages, the eminent French naturalist, called the attention of the French Academy to the depreciation and abandonment of many oyster beds on the shores of the Channel. In 1858 the gradual increase in the prices of oysters in France, consequent on their growing scarcity, attracted the attention of M. Coste, the celebrated pisciculturist, and since that time several beds on the coast of Brittany and elsewhere have been entirely renewed through the exertions of this gentleman. In this country the oyster was also becoming scarcer and scarcer every day, having doubled in price during the last few years; and if some remedy was not speedily found, these delicious bivalves would soon become extinct. Luckily, the shores of the British islands afforded numberless localities in which oyster culture could be carried on with ease and success. The method adopted by the French cultivators as carried on on the foreshores on that part of the shore lying between high and low water mark was thus described:—The shore is divided into allotments by means of low walls, each allotment being called a park, in which are placed tiles covered with old shells, bits of rock, &c., fixed in their places by cement. It is upon these that the spawn, or spat,

of the oyster collects and attaches itself. Besides these parks, there are *étalages*, or places on the foreshore where the oysters are laid down to fatten for market; *claires*, or enclosures, having similar objects; and *viviers*, or *vivaria*, where the oysters are stored. The conditions necessary to ensure success are few. A fine sheltered shore, free from weeds and muscles, and with just a little but not too much mud, is best fitted for an oyster park. For large operations in a considerable depth of water, like that carried on so successfully by M. Coste when he re-stocked the bay of St. Brieuc, nothing is better than large fascines of branches bound together with a thin chain of galvanized iron wire, and sunk by means of a heavy stone. For small parks on the foreshore the tiles already spoken of are used, which are the invention of Dr. Kemmerer, the able and zealous oyster-culturist of the Isle de Rhé. Mr. Lowe then gave an account of the life of an oyster from the spat to the fattened native, from which it appears that although each oyster produces spawn amounting to millions of individuals, yet hardly half-a-dozen of them ever arrive at maturity.

Oyster culture has already taken firm root in the island of Guernsey in several localities pointed out by Mr. Lowe as particularly adapted to the purpose while visiting the island about three years since; and preparations are now being made at Prittlewell, between Southend and Shoeburyness, for the establishment of oyster-parks on the French principle by the Fish and Oyster Culture Company. The company has already laid down 1500 bushels of full-grown oysters, which have been spread over about five acres of ground in such a way as to leave room for the placing of 50,000 Kemmerera collecting tiles. It is calculated that if each tile collects only 10 spat, the crop secured in one year will amount to 500,000 oysters, the value of which will be 1000*l.* Mr. Lowe then alluded to the legal difficulties standing in the way of oyster culture. The foreshore belongs to the Crown, but upon proper representations being made, Parliament would no doubt see fit to cede that right under certain limitations. An interesting discussion followed, led by Mr. Ffennell, Inspector of Fisheries. He said that the coast of Ireland abounded in localities most favourable to oyster culture, and instanced the fact of accidental oyster beds having been found in several places. In Cork river a most profitable oyster-bed was now being worked which owed its origin to a number of unsaleable oysters having been thrown overboard from a vessel anchored just above the harbour. If such results were due merely to accident, how much greater might be expected from systematic cultivation! A great deal of opposition had been raised to oyster culture, and it had been said that a number of poor people would be deprived of their bread; but no stress need be laid on these representations, as it was a well-known fact that almost every oyster fishery in this country was decaying. He mentioned one on the coast of Ireland, which a few years since sent oysters to market, the freight alone of which amounted

to 1000*l.* per week, whereas now the total produce hardly reached 300*l.* a year. Mr. Ffennell was followed by Messrs. Mitchell, Ridley, Ashton, Buckland, Tegetmeier, and several others, all of whom were unanimous in their opinion that oyster culture should be at once established in this country. A vote of thanks was then passed to Mr. Lowe by acclamation for his very interesting and eloquent paper, and the meeting separated. The lecture was copiously illustrated by a large number of specimens collected by Mr. Lowe during an official visit paid by him last year to the oyster grounds on the west coast of France; and by photographs of oysters in different stages of development, exhibited by means of the magic lantern.—*Times Report.*

CHANGE OF FORM IN INSECTS.

Mr. A. R. Wallace has exhibited to the Entomological Society various species of Papilio, Eronia, and Pieris, with a view to show the effect of locality in producing Change of Form in Insects. A number of species from the island of Celebes were selected, and compared with their nearest allies from the adjoining isles; the Celebes insects had, in every instance exhibited, the anterior margin of the fore-wings much more strongly arched than was the case with the allied species with which they were contrasted. Mr. Wallace had a theoretical explanation to offer for this phenomenon. He conceived that the insects had become modified in form by the external conditions to which they had been subjected; and that this modification was to be accounted for by some physical change which had occurred in Celebes, but not in the now adjacent isles. He was inclined to think that the falcate or arched form of wing gave great facility in twisting or turning rapidly about: if so, the Celebes form of butterfly-wing would enable the insect more easily to escape from its enemies and pursuers; those with the arched wings would have the best chance of surviving; the less-favoured forms would gradually be killed off; the offspring of the survivors would for the most part resemble, and some few would excel, their parents in the possession of the advantageous shape, and "natural selection" through successive generations would lead to the gradual and regular increase of the peculiarity.

DECAY IN WOOD CARVINGS.

From the Report of the Commission appointed by the Science and Art Department to inquire into the cause and prevention of Decay in Wood Carvings, we learn that the insects in this country found to be the most injurious from their habit of burrowing into the wood of furniture, belong to three species of beetles of small size, of the family *Ptinidæ*, and known under the systematic names of *Ptilinus pectinicornis*, *Anobium striatum*, and *Anobium tessellatum*. The conclusions at which the Commission has arrived are:—

That the action of these worms may be arrested, and the worms themselves destroyed by vaporization, more especially by the vapour of benzine, as appears from the successful results arrived at in the Bodleian Library in the destruction of the bookworm (of course the *insect* is referred to). To apply this it will be necessary to have a room sufficiently large to take in any piece of carved work or furniture, which may show symptoms of decay. The room should be so constructed that it can be closed and made as perfectly air-tight as possible, but with means of renewing the benzine, placed in saucers, from time to time, as it evaporates, without opening the ordinary means of access, or entering the chamber; as also of ready ventilation after the objects are considered to have been sufficiently treated, and before any person enters the room for the purpose of removing them. The process must always be carried out during the spring and early summer months, according to the state of the temperature. The practicability of complete restoration of carved work is fully shown in the results of Mr. Rogers's labours at Belton. The important question, however, as to the restoration of *gilded* carved work, and of panels on which pictures have been painted, and which have been attacked by the worm, presents difficulties which at present there seems to be no means of overcoming. That the worm could be destroyed by vaporization, as in all other cases, appears certain; and there is no reason to suppose that the vapour of the benzine would influence either the gilding of the one or the colours of the other, especially if applied in the latter case to the back of the picture. After the worm has been destroyed by the course of action proposed, further attacks from it can be prevented by treating the carved work with a solution of corrosive sublimate (chloride of mercury), either in methylated spirits of wine or parchment size, according to the surface-character of the carving or wood-work; the strength of the solution in each case being sixty grains of the chloride of mercury to a pint of fluid, whether spirits of wine or parchment size. As there was some uncertainty as to the fact whether *all* the ova of the beetle deposited in one year became developed to the worm state in the next, two cases, experimented upon during the spring and early summer months of 1863, were kept with the specimens intact, until after midsummer 1864, in order that it might be observed whether any worms or beetles make their appearance during the ensuing season. It has now been proved that the ova deposited previous to the objects being subjected to the action of chloroform or benzine were not *all* developed in 1863, the season in which the experiments were made. The vaporization, therefore, should be repeated more frequently than would otherwise have been necessary if all the ova of one year were developed, and came to maturity in the next.—*Reader.*

WASPS.

Irish Wasps (Vespidæ) form the subject of a paper by Mr. R. L. Edgworth, in the June number of the *Annals of Natural History*. He begins by proving the incorrectness of Réaumur's calculation, that 30,000 wasps could be contained in any average nest, and considers that 2800 would be about the maximum. The situation in which a wasp builds its nest is said to be characteristic of its species. The nests of *Vespa vulgaris* are generally formed on dry banks, in the roots of decayed trees, and occasionally in the thatch of cottages or other similar places, but may occur almost everywhere. A nest was once found in a loaf of sugar, the shell being partly composed of the surrounding thin paper. The wasp invariably builds beside the nest of a wild bee, either the *Bombus terrestris* or *Agrestis*. (In about 90 per cent. of nests Mr. Edgworth found this to be the case.) Wasps, if possible, choose a sloping place in which to build, so that the earth they have been mining may easily roll out of the hole, so much so that at the entrance of their nest a quantity of loose earth is generally to be

seen, as if a mouse had been burrowing. Mr. Edgworth describes carefully the mode to be adopted in conveying a whole nest of wasps to a position where their habits may be observed and studied. He denies the story of their killing their young at the first cold of winter, and thinks that possibly the grubs, in some rare cases, may have been killed by an early frost. He asserts that the love which wasps display both for their young and for the place of their birth is very remarkable. Mr. Edgworth says: "I have seen them linger for upwards of twenty days around some fragment of their cells when the nest itself had been carried away. Wasps soon become familiarized with any animal or with man." The food of the common wasp appears to be very various; indeed, this insect seems to be able to eat almost anything. In the early months of the year, whilst they are still rapacious, their diet seems to be nearly exclusively animal; but in the later months a vegetable fare seems more grateful to their effeminate natures. They are said to be very fond of bees. They devour raw meat, fish, sweet things of every sort, flies, butterflies, spiders; and they have been observed to kill even dragonflies, and to carry off the grubs from an ant's nest which had been disturbed.

Mr. F. Smith has exhibited to the Entomological Society a series of six wasps' nests, belonging to Mr. Stone, of Brighthampton, which were built in cubical boxes and of most singular shapes; one was compared to a stalactite cavern, and another was a fair representation of Stonehenge; the whole of the series had been executed by a colony of *Vespa Germanica* in thirty-eight days, in the months of September and October, 1862; but information was wanting as to the means employed to induce the wasps to build these fantastic structures.

TRAP-DOOR SPIDERS.

Mr. R. F. Wright has described to the British Association some curious Trap-door Spiders from Corfu. This spider makes a dwelling-place for himself by excavating in a sloping bank a circular hole about three inches in depth by one-third in diameter; this he lines with a silky web, and at the mouth of the hole he fixes, in a most artistic manner, a circular door with a hinge, composed of clay moistened with the glutinous substance of which the web is composed. This door he always shuts after going in or out. As soon as he finds a stranger at his door he secures it on the inside, possibly by holding it down with his claws, which are very powerful. It is necessary to use some force to open it.

PHOSPHORESCENCE OF THE CUCUYOS.

The Phosphorescent Light of the Cucuyos—a coleopterous insect of the genus *Pyrophorus*, of the family of the *Elaterides*, very abundant in the intertropical region of America—has been examined by M. Pasteur, by the spectrum apparatus, at the request of the Abbé Moigno, the editor of the *Cosmos*. The Mexican ladies use these insects for ornamental purposes, feeding them with sugar-cane and bathing them carefully two or three times a day. The light proceeding from the two small bodies on the insect's head is sufficiently vivid to give the power of reading in a dark place. M. Pasteur has reported to a meeting of the French Academy that he found the spectrum of this light to be very fine, but continuous, without any appearance of rays; his observations in this respect agreeing with those of M. Gernez, who had previously studied the light of phosphorescent worms by means of the spectroscope without discovering either obscure or brilliant rays. The cucuyos shows the same light under the abdomen, between the corslet and the wings. It is probable, as observed by M. Milne-Edwards, that the substance susceptible of becoming luminous is spread all over the body. M. E. Blanchard, at the same meeting, insisted on the great interest of researches which might lead to an accurate determination of the structure of the organs or tissues which secrete the phosphorescent matter. In a note in the *Memoirs of the Academy of Sciences* for 1766, Dr. Bondaroy states that some coleopterous insects of this genus, which had been brought alive to Paris in some old wood, caused great alarm in the Faubourg St. Antoine on their discovery.

THE PHOSPHORESCENCE OF THE LAMPYRIS ITALICA

Has been subjected to experiment by M. Carus, and the results communicated to the French Academy of Sciences. He finds that when the shining unctuous matter is taken away from the body of the insect, and placed on a glass and dried, it immediately loses its phosphorescence; but, as soon as the glass with this matter is placed under a little water, its luminosity returns. He hopes that this quality may be considered now that the light can be examined and analysed by the spectrum apparatus, since no other substance, not even phosphorus, begins to shine when placed under water, and loses this property when dried. In the *Lampyris Italica* the light is not equal and tranquil, as is the *Lampyris noctiluca*, but is flashing; and in its periodicity answers exactly to the pulsations of the heart of the insect, since each wave of the blood, by moistening the luminiferous matter, gives it momentarily a more dazzling brilliancy.

SILKWORMS.

Capt. Hutton, in a paper read to the Entomological Society, "On the Reversion and Restoration of the Silkworm," attributes the great loss of silkworms by "muscadine" and other diseases to the combined effects of bad and scanty food, want of sufficient light and ventilation, too high a temperature, and the constant interbreeding of a debilitated stock; he has for several years been experimenting upon *Bombyx mori*, with a view, if possible, to restore to the worms

a healthy constitution, to induce them to revert from their present artificial and moribund condition to one of vigour and permanent health. He regards the occasional occurrence in a brood of a few dark-grey or blackish-brindled worms—the "*vers tigrés*" or "*vers zébrés*" of the French—as an attempted return on the part of Nature to the original colours and characteristics of the species; and has come to the conclusion that, in fact, the dark worms, generally rejected by the sericulturist, are the original and natural worms, and that the whiteness of the pale sickly hue of the majority is a positive indication of degeneracy, and of the destruction of the original constitution. The author explained in detail the steps by which he had raised a strong and healthy stock of dark worms, and recommended every sericulturist to separate his dark worms from his general stock, to set them apart for breeding from, and to annually weed out all the pale-coloured ones; in the course of three or four years he would be able to cast his present sickly worms, and would have acquired a stock far healthier than had ever before been seen in Europe.

Dr. A. Wallace has exhibited to the Entomological Society the silk of *Bombyx Cythnia* fed on the Ailanthus; specimens of the silk as carded from the cocoon, spun silk and woven silk, were all shown, together with a skein of *ailanthine* spun from the cocoon in a continuous thread.

A new species of Chinese Silkworm has been laid before the French Academy of Sciences by M. Guérin-Méneville, who has already introduced three species—the *Bombyx Mylitta* of Fabricius (from Bengal), his own *Bombyx Pernyi* (from the north of China), and *Bombyx Yama-Maï* (from Japan). The fourth species, now first brought to Europe, is the *Bombyx (Antheræa) Roylei* of Moore, twenty cocoons having been sent to M. Guérin-Méneville by Capt. Hutton, who obtained them from the elevated plateaux of the Himalaya on the frontier of Cashmere. The worm feeds on the thick leaves of the oak, *Quercus incana*. The cocoon differs from that of the other three species in its greater size and in its being surrounded with a silken envelope of a pretty grey colour. M. Guérin-Méneville believes that the new species might be easily naturalized in the centre and north of France, the climate of which does not differ essentially from that of the elevated parts of the Himalayas.

RAVAGES OF WHITE ANTS.

A COMMUNICATION from the Lords of the Admiralty has been read to the Entomological Society, enclosing a copy of a circular letter from the Governor of St. Helena, respecting the ravages committed in that island by the White Ants. It is therein stated that the insects were, it is supposed, accidentally introduced from the coast of Guinea about twenty years since; that almost every dwelling, store, or shed in Jamestown, containing nearly 4000 inhabitants, has been seriously injured by them, involving in many instances complete ruin and abandonment, and imperilling the lives of large numbers of the poorer classes, who are still living in houses of doubtful security. The Governor is especially anxious for detailed information as to the most successful mode of finding the ant's nests, and effectually destroying those receptacles, and as to the description of timber which has proved to be the least susceptible of injury from the insect, and the average market price of that timber at per cubic foot. Gen. Sir J. Hearsey, after detailing some of his own experiences in connexion with the white ants in India, said, that the nests must be sought in the plain; that if once the ants effected a lodgment in the walls of a house, the walls themselves must be taken down before the insects could be eradicated. He thought the best preventive of their attacks was to steep the timber before building in a solution of quicklime, and completely saturate it therewith; whilst store-boxes, furniture, and small articles should be painted over with a solution of corrosive sublimate. Mr. E. W. Robinson said that, on the Indian railways, a solution of creosote was applied to the sleepers; it was, however, insufficient merely to coat the wood over with the creosote, but the whole block must be impregnated with it; and, in fact, the creosote was forced through the timber by hydraulic pressure. Mr. H. W. Bates said that the houses on the banks of the Amazons were not much infested with white ants, which he attributed in a great degree to the use of a very hard wood called Acapù; it was the habit to rest store-boxes, &c., on sleepers, or cylindrical pieces of that wood, which in many cases afforded sufficient protection. When the ants had effected an entry into the walls (which in the Amazon country were principally composed of upright posts with cross laths, filled up with mud, and covered with lime or cement), he had found it an unfailing remedy to fill up the holes in the walls with arsenical soap; oxide of arsenic might be used, but that of course was attended with danger; the arsenical soap was cheap, and might be diluted with water, and boxes, &c., might be washed over with the solution. The most effective method would, however, be to completely saturate and poison the timber, as Gen. Hearsey had mentioned with respect to the quicklime.

HOW TO DESTROY ANTS.

AN agriculturist, M. Garnier, has announced an infallible method for getting rid of Ants. In a corner of his garden infected with legions of these insects he placed four saucers containing sugar and water, with the tenth of its weight of arsenic in the mixture. A number of ants immediately invaded the saucers, but were soon after perceived staggering away, as it were, and some being even engaged in dragging their dead comrades away. From that moment they disappeared from the garden, and on the following day not a single one was to be seen. How and whither this immense population emigrated in so short a time is a mystery which M. Garnier has been unable to clear up, and is inclined to attribute it to some mysterious instinct.—*Paris Letter.*

THE STING OF REPTILES.

In a paper addressed to the French Academy of Sciences, Dr. Guyon lays down the principle that the action of the venom of Serpents as well as Scorpions is identical on man as on beasts, a proposition he confirms by several observations of his made both in the West Indies and in Algeria. Regarding its violence, he says there is a general belief abroad that it is much more powerful in summer than in winter; but this he does not consider well authenticated, and quotes against it the case of one Drake, an exhibitor of snakes, who having in the winter of 1827, at Rouen, handled a rattlesnake which he took to be dead while it was only benumbed by the cold, was bitten by it, and died in the course of nine hours. From a considerable number of observations, Dr. Guyon concludes that the intensity or power of the venom is less owing to difference of season than to the length of time it has been accumulating in the reservoir of the reptile; and the greatest accumulation necessarily occurs during winter, because the animal is in a torpid state, and does not take any food during that season. So it was in the case of Drake, and so Dr. Guyon found it in that of a horned viper, which had been given him at the caravanserai of Sidi Makhlouf, Algeria. The reptile had been put into a bottle, which had since remained hermetically closed. It had been in there for six weeks without food and without air, and looked quite dead, since it could not stir in the bottle, which it filled entirely. And yet, on opening the bottle, the doctor found the reptile perfectly sound, and saw it kill a large fowl instantaneously with its sting. Our author quotes another case, that of a scorpion that had been kept in a bottle for a long time, and on being released killed two sparrows in less than a minute, and a pigeon in three hours. Dr. Guyon devotes some space to the symptoms which accompany the infliction of a bite by such reptiles—first, a violent pain at the moment of receiving the wound, then an unconquerable itching on the spot, then trembling, vomiting, difficulty of breathing, often accompanied with a cough, a dilatation of the pupils, muscular contractions, tetanic symptoms, &c.—*Galignani's Messenger.*

THE SCORPION.

The French Academy of Sciences has received a paper from Dr. Guyon on the mortal effects of the African Scorpion's sting. Its scientific name (*Androctonus funestus*), indeed, expresses that it is fatal to man, and yet Dr. Guyon states that perhaps out of 100 persons stung there is scarcely one that dies of it. The ancients, who under the name of scorpion certainly mean the same insect, since it is found represented on Egyptian monuments, and even engraved on precious stones, had a much stronger opinion of its deadly effects. Lucan, in his *Pharsalia*, b. ix., says: "Who would believe, on seeing the scorpion, that it has the power of causing such a sudden death?" Leo Africanus states that the houses of Biskra are infested with scorpions, which are so venomous that death ensues immediately after the sting. Abd-Allatif, an Arabian physician and traveller, says: "At Koos abundance of scorpions are found, whose sting is frequently mortal." Dr. Guyon knows of eight cases in which the sting of the African scorpion was followed by death; three of the sufferers were men, two were women, and three children. Two of the latter cases occurred in 1856, near Laghouat, in Algeria. One was that of a boy nine years old, who was stung on the forefinger of the left hand by a scorpion, which was seen and crushed on the spot. This occurred at eight o'clock A.M., and before noon on the following day the patient died. The sting had caused violent pain, increasing in proportion as the swelling extended to the arm. The boy had cried a long time, and then vomited considerably. The swelling was in a great measure owing to the ligature which the Arabs always effect above the wound in such cases. The other case was nearly similar. Dr. Guyon states that children are more liable to die from the effects of the sting than adults, and that among the latter those who are stung somewhere on the head are most likely to die of it.

TWO-HEADED SERPENTS.

In the *Proceedings of the Boston Society of Natural History* (U.S.) is an account of two specimens of monstrosity in Serpents given by Professor Wyman at a meeting of the Association. One of these was a young black snake (*Coluber constrictor*), which had two complete heads united to a single trunk. The vertebral column was double for a short distance behind the head, and over the same region the transverse black bands usually found in the young of this species were divided lengthwise. The second was a water-adder (*Tropidontus sipedon*), belonging to the Massachusetts State Collection. In this the heads were more widely separated than in the preceding one, each head being supported by a distinct neck. The tail was also double for about an inch. The most remarkable deviation was found near the middle of the body. In this region the size is considerably increased, and the transverse dark bands of the skin are interrupted in the middle, the lateral portions remaining. On the middle line passing between these is a longitudinal zigzag line, which extends the whole length of the enlarged portion. In this region the vertebral column is double, and provided with a double set of ribs, but is single before and behind it. The doubling of the vertebral column in its central portion in the manner above described is of very rare occurrence, and does not appear to have been noticed in the various works treating on teratology. Monstrosities of serpents in which the head is double have been often noticed. Aristotle mentions such. Redi found one alive, sunning himself on the banks of the Arno, near Pisa, which was two palms in length and as large as the little finger. The heads were of equal size, and each supported by a neck of two fingers' breadth in length. Redi preserved it alive for

several weeks, and tried experiments with it. He noticed that the right head died seven hours before the left. In this case the brain and spinal marrow were double as far as the middle of the back, beyond which the spinal cord was single. The œsophagus and stomach were double, but the stomachs were connected with a single intestine, and there were two hearts and two livers.

THE MEXICAN BASILISK

Is described by M. Sumichrast, in his paper on Mexican Reptiles, in the *Annals of Natural History*. He states that it does not in any way resemble in its habits the fabulous creature to which the ancients gave the name Basilisk. It is common on the margins of nearly all the rivers of the warm and temperate regions of Mexico. As soon as the sun has warmed the air in spring he quits his nocturnal retreat and commences the pursuit of his prey. If the dry trunk of a tree rises from the margin of the water, we may be almost certain of finding upon it, during the hot hours of the day, a basilisk acting the part of a sentinel. With his body voluptuously extended, as if to absorb as much as possible of the solar heat, he remains in a state of perfect quietness; but if some noise attracts his attention, he raises his head, inflates his throat, and rapidly agitates the membranous crest with which his occiput is crowned. His piercing eye, with its dull yellow iris spangled with gold, glances inquisitively on every side; if the danger be imminent, his body, previously flaccid and soft, draws together like a spring, and, leaping with the rapidity of lightning, he throws himself into the water. In swimming, he raises the head and breast, his fore feet strike the water as oars, whilst his long tail furrows it like a rudder. He lives entirely on insects, which he captures with much dexterity.—*Illustrated London News*.

BOTANY.

CHLOROPHYLL,

The green colouring matter in plants, has been closely examined by Professor Stokes, Sec. R.S., by the spectroscope. In the *Proceedings of the Royal Society* he records that he finds the Chlorophyll of land plants to be a mixture of four substances—two green and two yellow—all possessing highly distinctive optical properties. The green substances yield solutions exhibiting a strong red fluorescence; the yellow substances do not. The four substances are soluble in the same solvents, and three of them are extremely easily decomposed by acids or even acid salts—such as binoxalate of potash; but, by proper treatment, each may be obtained in a state of very approximate isolation, so far, at least, as coloured substances are concerned. Professor Stokes also examined a specimen, prepared by Professor Harley, of biliverdin, the green substance contained in bile, supposed by Berzelius to be identical with chlorophyll, and was thereby enabled to prove that the two substances are quite distinct.

THE WHEAT CROP OF 1864.

Mr. J. B. Lawes, the scientific agriculturist, writes from Rothamsted to the *Times*:—"In October last you favoured me with space for a few remarks on the character of the Wheat Crop of 1863. Founding my conclusions upon the produce obtained in a field of 14 acres, in which wheat had been grown for 20 years in succession, on some portions without manure, and on others with different descriptions of manure, and also upon a careful comparison for many years past of the results obtained in that field with those of ordinary farming over a large area of the country, I gave it as my opinion that the crop of last year (1863) would turn out a remarkably abundant one; and such subsequent experience has proved it to have been. I now propose to direct the attention of your readers to a few of the results obtained in the same field during the season just passed, which is the 21st of wheat, year after year, on the same land.

Bushels of Dressed Corn per Acre.				
Plots.	—	Harvests.		Average of 12 years.
		1863.	1864.	1852–63.
3	Unmanured	17¼	16	15½
2	Farmyard Manure . . .	44	40	35¾
7	Artificial Manure	53⅝	45¾	36⅜
8	Do. do.	55⅝	49⅞	38
9	Do. do.	55½	51¼	34½
16	Do. do.	55⅞	51	38½

Weight per Bushel of Dressed Corn—lbs.				
Plots.	—	Harvests.		Average of 12 years.
		1863.	1864.	1852–63.
3	Unmanured	62·7	62·0	56·5
2	Farmyard Manure . . .	63·1	62·5	59·3
7	Artificial Manure	62·6	63·1	58·4
8	Do. do.	62·3	63·5	57·8
9	Do. do.	62·1	62·6	57·1
16	Do. do.	62·4	63·2	57·8

"Above are given, for the Harvest of 1864, the number of bushels per acre, and the weight per bushel, of the dressed corn obtained—on a portion left entirely unmanured during the whole 21 years, on another manured with 14 tons of farmyard dung every year, and on others manured with certain artificial mixtures in each of the 21 years. And, for the sake of comparison with the results of the present season, there are given, in parallel columns, those of 1863, as well as the average over the last 12 years, during which period the description of artificial manure

applied was the same year after year on the same plot as for the crop of 1864. It may be added, that the different artificial mixtures contained the same mineral manure in each case, but in combination either with different quantities of ammonia-salts, or with nitrate of soda.

"It is seen that the produce of 1864 was in every case less than that of the extraordinary season of 1863; but that it was, on the other hand, in every case considerably higher than the average of the preceding 12 years. Indeed, on two of the plots the produce of the present season exceeded the average of the preceding 12 years by about 12, and on one by more than 16 bushels per acre. The quality of the grain is also very high, as indicated by the weight per bushel, which is fully equal to that of 1863, and very much higher than that of the average of the preceding 12 years. It is remarkable, too, that in three of the experiments the produce of the last two years taken together has exceeded 100 bushels per acre. In no other instance during the 21 years has the produce of two consecutive seasons given such a result. The nearest approaches to it were in 1857 and 1858, when one plot gave 92 bushels, and in 1862 and 1863, when several plots gave over 90 bushels per acre in the two years.

"Upon the whole I think it may be concluded that, on the heavier soils, if in good condition, the wheat crop of 1864 will prove to be much above the average. On light and badly-farmed soils, on the other hand, I think the produce will generally be below an average. The quality is doubtless pretty universally good, and above the average. With such a crop following one of such unusual abundance as that of last year, it is not surprising that the price of wheat should be so low."

GIGANTIC MUSHROOMS.

The following notice concerning the production of Mushrooms of gigantic size was communicated to the French Academy in 1861 by Dr. La Bordette (*Vide Comptes Rendus*, t. liii. 1861, pp. 235 and 671). The Doctor was engaged in experimenting upon the subject during several years. The Mushrooms are first developed by putting their spores (dust-like seeds) upon a glass plate spread over with sand and water. The most vigorous individuals are selected, and it was with the *mycelium* (spawn) of these that he obtained the remarkable specimen presented to the Academy. The process is as follows:—A moist soil, composed of vegetable mould from marshy ground (known as *terre végétale de maraîcher*), placed in a cellar, is covered first with a layer, about 10 inches thick, of sand and river gravel, and then with a layer, about 6 inches thick, of the mortar of old buildings got during their demolition. This soil, after the spawn has been sown in, is sprinkled with water containing about 32 grains of nitrate of potash (saltpetre) per square metre (about 10 square feet). The action of the nitrate of potash was manifested during six years.

Dr. La Bordette informed the Academy that he had succeeded in raising mushrooms on a soil formed entirely of sulphate of lime (gypsum, which by calcination yields common plaster of Paris), well beaten down. For manure he substituted nitrate of potash buried along with mushroom spawn at a depth of three or four millimetres (0·12 or 0·16 inch). Nothing else was added. "Under these conditions," says the Doctor, "the growth of a variety of the common mushroom (*Agaricus campestris*), which may be termed 'giant mushroom,' takes place indefinitely. While, according to the usual and complicated method of culture, the average weight of mushrooms in the adult state is 100 grammes (1544 grains), mushrooms may be developed by my method weighing on the average 600 grammes (9263 grains, or somewhat more than 1¼lb. avoirdupois)."

CHINA GRASS.

Satisfactory experiments have been made at Lille with China Grass and Cotton mixed; an excellent fabric having been obtained from the loom, far more durable than calico, and equally capable of being dyed. Reports presented to the Chamber of Commerce recommend the introduction of China grass into the manufacture of stuffs hitherto made of cotton alone. Such stuffs, it may be surmised, will hold an intermediate rank between linen and pure cotton fabrics. China grass, in a raw state, consists of long herbaceous blades of a yellowish hue, but when prepared it has quite the appearance of common cotton, except that it has a sort of silky gloss which the latter has not. It is soft to the touch, supple, and free from all kinds of knots. The plant admits of being acclimatized in the south of France, and generally wherever cotton has been cultivated since the outbreak of the American war. It spreads with great rapidity, even when left to itself, and its cultivation gives little or no trouble. At Calcutta it yields three crops a year, with stalks of the length of from six to nine feet. The Minister of Agriculture and Commerce has ordered over a quantity of China grass seed from its native country, in order to distribute it to all agriculturists who may apply for it. Regarding the cost, MM. Mallard and Bonneau, of Lille, state it as follows:—100 kilogrammes of China grass treated by their process yield 75 per cent. of cotton-like matter, 8 per cent. of refuse applicable to the manufacture of paper, and 17 per cent. of waste which is good for manure. The chemical treatment and the various manipulations requisite for obtaining the material fit for spinning cost together 1f. 57c. per kilogramme. As the cotton of Egypt now costs 5f. 60c., the difference in favour of China grass is 4f. 3c. To this must be added 10 per cent. for the cleaning or picking and consequent waste of the said cotton, which raises the difference in favour of the new material to 4f. 59c. This is irrespective of the profit to be derived from the refuse to be sent to the paper-mill. If all these calculations be correct, China grass will be a boon to mankind.—*Galignani's Messenger*.

SUBSTITUTES FOR GUTTA PERCHA.

Dr. R. Riddell has read to the British Association a paper "On Balatta and other Gums regarded as a Substitute for Gutta Percha." The paper spoke of the gum as a very excellent substitute for, and quite equal to, the adulterated or re-boiled gutta percha from Singapore. They were indebted to Dr. Van Holst, of Amsterdam, Berbice, for bringing this gum first into notice in 1860. It abounded in the forests of British Guiana, and was especially prolific at the time of the full moon. On the day of the full moon the yield of gum was from six to ten times greater than at other times. After the tree had been tapped, it could be tapped again every two months. The wood was used for building purposes and for furniture, and he was informed the tree was not injured by being tapped. A tree yielding a gum similar in every respect was discovered to exist, by Gen. Cullen and Col. Cotton, in 1853, growing along the whole line of the Western Ghauts on the Malabar coast, Southern India, from lat. 8° 30′ to lat. 10° 30′ at an elevation of from 2500 to 3000 feet above the sea. The climate of the country where the Bullet-tree is found in Berbice is unhealthy; but, however that may be, probably some of the free slaves of America might be induced to settle there and become traders.

The Rev. A. M. Norman, alluding to the fact mentioned by Dr. Riddell, of the sap flowing more freely at the time of the full moon, said, some people were inclined to laugh at such statements, but there could be no doubt that the moon had an important influence on the vegetable world. Dr. Riddell said: It is well known to the natives of India, that bamboo cut at the full moon was much more subject to the attacks of insects, rotted and decayed sooner than when cut during the dark nights. Specimens of the gum, in a liquid state, also in a large block, and rolled, were exhibited, appearing freely coloured, but not very agreeable in smell. Other specimens were shown in a manufactured state, as vulcanized, hard and soft, and in a state of ebonite. A patent has been taken out for working it, particularly for the insulation of electric wires, combined with caoutchouc and various other substances.

A HORSECHESTNUT TREE.

Colonel Greenwood writes from Brookwood Park, Alresford, to the *Athenæum*:—

D. Davy read a paper at Bath on *the* Horsechestnut: will any one read a paper on *a* horsechestnut? The tree stands on a flat stone. Its *root* grows *up* through the air for seven feet, turns over a wall, and descends seven feet into the earth. So that the root passes for fourteen feet through the air before it enters the earth. The celebrated Dutrochet, by experiment, convinced the still more celebrated De Candolle, and all European vegetable physiologists, that roots will only grow straight downwards. On this, I set to work to show that they will grow in any direction in which they can find food. If any one doubts this *fact*, let him inspect my tree, which is now twenty-one years old. In imitation of Dutrochet's beautiful experiment, I placed a great variety of seeds (single as well as double) in flower-pots, suspended them upside down

on wire-work, and watered them from above. Each seed sent a tap-root down into the air, which died: but the *branch* roots (as I have named them) and the plants grew, and corn ripened in this way. But *cuttings* placed upside down, though they grew and bore fruit for years, showed no root below. I thus blundered on the fact that every seedling has a tap-root, whose downward determination nothing can pervert; a *provision* and *contrivance* for the fixing of the plant, and a beautiful proof of the *design* of a Creator. But the downward tap-root is as peculiar to the seedling as the "seed-leaves" are, and all *branch* roots will grow in all directions. I published this in the second edition of the "Treelifter," in 1853, where the details may be seen. Those who have published it since have neglected to say where they got it from. I preserved one horsechestnut by placing it on a flat stone, and replacing the flower-pot with a chimney-pot full of earth, and, by degrees, raised a column of chimney pots. I then built up a column of earth on the opposite side of the wall, turned the roots into it, and when they were established in the ground I took away the two columns of earth. I think that Virgil's tap-root Esculus (*quæ quantum vertice*, &c.) is the horsechestnut. Virgil (second book of Georgics) mentions it as distinct from the quercus and castanea, and Ovid (Met. x. 91) as distinct from the fagus and ilex. It is then a feat to make its radix *tend* to heaven instead of to Tartarus. With regard to the name from Esca, it is true that neither man, horses, nor pigs will eat horsechestnuts, but sheep, cows, and deer are ravenously eager for them.

CULTURE OF POTATOES.

An Agricultural Society has been established at Planitz, in Saxony, under the title of "Society for the Cultivation of Potatoes." The association has already published a number of reports. One of them states that the best specimens of potatoes grown in sandy soil have quickly degenerated and given only an indifferent crop in the strong clayey land in the neighbourhood of Planitz. Since the foundation of the Society, in 1860, the members have made numerous experiments on strong, light, clayey, gravelly, and stony soils. The members procured samples of every description of potato sold, and they propagated those which produced the best results. After a year's trial they have generally found that the greatest number of potatoes succeed best in light and slatey land. They found, however, that the long potato from Algiers became rotten in sandy soil, and produced large and perfectly sound potatoes in strong land. The white English kidney potato planted in stony ground produced potatoes quite red. The Society has lately offered 10 kilogrammes of seed potatoes to any farmer who will contribute 5f. annually, on the sole condition that he will furnish a statement setting forth the quantity of potatoes produced and the nature of the soil in which they were planted.

M. Pousard, president of the Agricultural Society of Châlons, has addressed a paper to that body, in which he states that he has discovered a remedy for the Potato Disease. The secret consists in planting potatoes after the 1st of June, instead of in April. By this plan they escape the frost of April, and the leaf is not exposed to the hot sun of July. M. Pousard is of opinion that the alternate frost and heat corrupt the root by their opposing influence. It appears that he has continued his experiments for several years, and that his potatoes are of a fine size and perfectly sound. M. Pousard is able likewise by this plan to grow two crops on the same ground within the year.—*Abridged from the Times.*

THE MISTLETOE.

Dr. John Harley, in the *Transactions of the Linnæan Society*, has published his investigation of the physiological relations of Mistletoe to the plants upon which it grows; his observations being chiefly made on the maple, hawthorn, apple, willow, and oak, with regard to the mutual growth of the two plants. The following abstract is from the *Illustrated London News*:—

"The Mistletoe attaches itself to the nourishing plant by roots, some in the bark, others in the wood, the first being a single root or sucker, which presses inwards to the wood, and then ceases to grow; from this root proceed horizontal or side roots, generally five or six. The base of the parasite at its thickest part is about four-tenths of an inch in diameter, and is composed of a delicate yellowish-green cellular tissue. The roots are very perishable, and after the death of the stock soon crumble down into the woody cavities containing them. The anatomical relation between the mistletoe and the flourishing plant is shown by Dr. Harley in sections given in a series of plates. The young cellular root may be regarded as a prolongation of the central pith of the parasite, and the contiguous medullary rays of the nourishing plant are successively confluent with its surface, as shown in the plates; but the woody fibres of the two plants never come into actual contact. The former Dr. Harley believes to be an essential condition of its parasitism. He says:—'When the roots of viscum album have become fairly infixed into the medullary system of the nourishing plant, their outer portions become gradually thickened by the formation of wooden layers upon their surfaces. This increase in the lateral dimensions of the root takes place *pari passu* with that of the branch upon which it grows; for every layer of wood deposited upon the branch a corresponding one is deposited upon the mistletoe; and the growth of the two plants proceeding thus uniformly, the concentric rings of the stock pass uninterruptedly into those of the mistletoe, and the woody layers become coincident. While the roots thus undergo increase and lignification about their outer portions, their inner extremities, which now lie deeply in the hard wood of the nourishing plant, constantly retain their original soft cellular condition. And, as far as my own observations go, the life of the parasite depends upon these delicate cellular processes. They are, in fact, to viscum what the cellular rootlets of terrestrial plants are to them. When, through accident or old age, they die, secondary ones are thrown out from the soft outer layer of the woody base, which, after traversing the bark for a shorter or longer distance, come into relation with the medullary rays of the nourishing plant.' The invariable result of the attachment of the roots of the mistletoe to a branch is the increased development of its tissues. The branch still maintains its vigour, and slowly buries the intruder; new roots penetrate the freshly-formed layers of the wood, and are also resisted; but a second crop of roots spread destruction still further outward. The infected branch assumes various contortions, and frequently is found bent at right angles to itself. But it wrestles in vain with a veritable hydra, which, having killed its centre, spoiled and occupied its bark, and invaded anew the little living wood that remains, now gradually completes the work of destruction."

Geology and Mineralogy.

THE GLACIAL AND POST-GLACIAL PERIODS, ETC.

Sir Charles Lyell, in his luminous Inaugural Address as President of the British Association Meeting at Bath, in September last,* thus stated his views upon these important geological questions:—

"The vast mechanical force that ice exerted in the Glacial Period has been thought by some to demonstrate a want of uniformity in the amount of energy which the same natural cause may put forth at two successive epochs. But we must be careful, when thus reasoning, to bear in mind that the power of ice is here substituted for that of running water. The one becomes a mighty agent in transporting huge erratics, and in scoring, abrading, and polishing rocks; but meanwhile the other is in abeyance. When, for example, the ancient Rhone glacier conveyed its moraines from the upper to the lower end of the Lake of Geneva, there was no great river, as there now is, forming a delta many miles in extent, and several hundred feet in depth, at the upper end of the lake.

"The more we study and comprehend the geographical changes of the Glacial Period, and the migrations of animals and plants to which it gave rise, the higher our conceptions are raised of the duration of that subdivision of time, which, though vast when measured by the succession of events comprised in it, was brief if estimated by the ordinary rules of geological classification. The Glacial Period was, in fact, a mere episode in one of the great epochs of the earth's history; for the inhabitants of the lands and seas, before and after the grand development of snow and ice, were nearly the same. As yet we have no satisfactory proof that man existed in Europe or elsewhere during the period of extreme cold; but our investigations on this head are still in their infancy. In an early portion of the Post-glacial Period it has been ascertained that man flourished in Europe; and in tracing the signs of existence, from the historical ages to those immediately antecedent, and so backward into more ancient times, we gradually approach a dissimilar geographical state of things, when the climate was colder, and when the configuration of the surface departed considerably from that which now prevails.

"Archæologists are satisfied that in central Europe the age of bronze weapons preceded the Roman invasion of Switzerland; and prior to the Swiss lake dwellings of the bronze age were those in

* The Bath meeting was a highly successful one in point of attendance. The above Address, by Sir C. Lyell, in the Theatre, was read before an audience of 2300; the number of members who attended at the close of the week reached 2965, and the sum raised 2789*l*.

which stone weapons alone were used. The Danish kitchen-middens seem to have been of about the same date; but what M. Lartet has called the reindeer period of the south of France was probably anterior, and connected with a somewhat colder climate. Of still higher antiquity was that age of ruder implements of stone, such as were buried in the fluviatile drift of Amiens and Abbeville, and which were mingled in the same gravel with the bones of extinct quadrupeds, such as the elephant, rhinoceros, bear, tiger, and hyena. Between the present era and that of those earliest vestiges yet discovered of our race, valleys have been deepened and widened, the course of subterranean rivers which once flowed through caverns has been changed, and many species of wild quadrupeds have disappeared. The bed of the sea, moreover, has in the same ages been lifted up, in many places hundreds of feet, above its former level, and the outlines of many a coast entirely altered.

"MM. de Verneuil and Louis Lartet have recently found, near Madrid, fossil teeth of the African elephant, in old valley-drift, containing flint implements of the same antique type as those of Amiens and Abbeville. Proof of the same elephant having inhabited Sicily in the Postpliocene and probably within the Human period, had previously been brought to light by Baron Anca, during his exploration of the bone-caves of Palermo. We have now, therefore, evidence of man having co-existed in Europe with three species of elephant, two of them extinct (namely, the mammoth and the *Elephas antiquus*), and a third the same as that which still survives in Africa. As to the first of these—the mammoth—I am aware that some writers contend that it could not have died out many tens of thousands of years before our time, because its flesh has been found preserved in ice, in Siberia, in so fresh a state as to serve as food for dogs, bears, and wolves; but this argument seems to me fallacious. Middendorf, in 1843, after digging through some thickness of frozen soil in Siberia, came down upon an icy mass, in which the carcase of a mammoth was imbedded, so perfect that, among other parts, the pupil of its eye was taken out, and is now preserved in the Museum of Moscow. No one will deny that this elephant had lain for several thousand years in its icy envelope; and if it had been left undisturbed, and the cold had gone on increasing for myriads of centuries, we might reasonably expect that the frozen flesh might continue undecayed until a second glacial period had passed away.

"When speculations on the long series of events which occurred in the Glacial and Postglacial Periods are indulged in, the imagination is apt to take alarm at the immensity of the time required to interpret the monuments of these ages, all referable to the era of existing species. In order to abridge the number of centuries which would otherwise be indispensable, a disposition is shown by many to magnify the rate of change in prehistoric times, by investing the causes which have modified the animate and inanimate world with extraordinary and excessive energy. It is related of a great Irish orator of our day, that when he was about to contribute somewhat parsimoniously towards a public charity, he was persuaded by a friend to make a more liberal donation. In doing so he apologized for his first apparent want of generosity, by saying that his early life had been a constant struggle with scanty means, and that 'they who are born to affluence cannot easily imagine how long a time it takes to get the chill of poverty out of one's bones.' In like manner, we of the living generation, when called upon to make grants of thousands of centuries in order to explain the events of what is called the modern period, shrink naturally at first from making what seems so lavish an expenditure of past time. Throughout our early education we have been accustomed to such strict economy in all that relates to the chronology of the earth and its inhabitants in remote ages, so fettered have we been by old traditional belief, that even when our reason is convinced, and we are persuaded that we ought to make more liberal grants of time to the geologist, we feel how hard it is to get the chill of poverty out of our bones."

Sir Charles Lyell added:—"I will now briefly allude, in conclusion, to two points on which a gradual change of opinion has been taking place among geologists of late years. First, as to whether there has been a continuous succession of events in the organic and inorganic worlds, uninterrupted by violent and general catastrophes; and, secondly, whether clear evidence can be obtained of a period antecedent to the creation of organic beings on the earth. I am old enough to remember when geologists dogmatized on both these questions in a manner very different from that in which they would now venture to indulge. I believe that by far the greater number now incline to opposite views from those which were once most commonly entertained. On the first point, it is worthy of remark that, although a belief in sudden and general convulsions has been losing ground, as also the doctrine of abrupt transitions from one set of species of animals and plants to another of a very different type, yet the whole series of the records which have been handed down to us are now more than ever regarded as fragmentary. They ought to be looked upon as more perfect, because numerous gaps have been filled up, and in the formations newly intercalated in the series, we have found many missing links, and various intermediate gradations between the nearest allied forms previously known in the animal and vegetable worlds. Yet the whole body of monuments which we are endeavouring to decipher appears more defective than before. For my own part, I agree with Mr. Darwin in considering them as a mere fraction of those which have once existed, while no approach to a perfect series was ever formed originally, it having never been part of the plan of Nature to leave a complete record of all her works and operations for the enlightenment of rational beings who might study them in after ages.

"In reference to the other great question, or the earliest date of vital phenomena on this planet, the late discoveries in Canada

have at least demonstrated that certain theories founded in Europe on mere negative evidence were altogether delusive. In the course of a geological survey carried on under the able direction of Sir William E. Logan, it has been shown that northward of the River St. Lawrence there is a vast series of stratified and crystalline rocks of gneiss, mica-schist, quartzite, and limestone, about 40,000 feet in thickness, which have been called Laurentian. They are more ancient than the oldest fossiliferous strata of Europe, or those to which the term primordial has been rashly assigned. In the first place, the newest part of this great crystalline series is unconformable to the ancient fossiliferous or so-called primordial rocks which overlie it; so that it must have undergone disturbing movements before the latter or primordial set were formed. Then again, the older half of the Laurentian series, is unconformable to the newer portion of the same. It is in this lowest and most ancient system of crystalline strata that a limestone, about 1000 feet thick, has been observed, containing organic remains. These fossils have been examined by Dr. Dawson, of Montreal, and he has detected in them, by aid of the microscope, the distinct structure of a large species of Rhizopod. Fine specimens of this fossil, called *Eozoon Canadense*, have been brought to Bath by Sir William Logan, to be exhibited to the members of the Association. We have every reason to suppose that the rocks in which these animal remains are included are of as old a date as any of the formations named Azoic in Europe, if not older, so that they precede in date rocks once supposed to have been formed before any organic beings had been created.*

"But I will not venture on speculations respecting 'the signs of a beginning,' or 'the prospects of an end,' of our terrestrial system—that wide ocean of scientific conjecture on which so many theorists before my time have suffered shipwreck."

TEMPERATURE OF THE BATH WATERS.

SIR CHARLES LYELL, in his admirable Address, just quoted, drew a comparison between the hot spring and the volcano, adding, "the thermal waters of Bath are far from being conspicuous among European hot springs for the quantity of mineral matter contained in them in proportion to the water which acts as a solvent; yet Professor Ramsay has calculated that if the sulphates of lime and of soda, and the chlorides of sodium and magnesium, and the other mineral ingredients which they contain, were solidified, they would form in one year a square column 9 ft. in diameter, and no less than 140 ft. in height. All this matter is now quietly conveyed by a stream of limpid water, in an invisible form, to the Avon, and by the Avon to the sea; but if, instead of being thus removed, it were deposited around the orifice of eruption, like the silicious layers which incrust the circular basin of an Icelandic geyser, we should see a considerable cone built up with a crater in the middle."

* Sir William Logan has placed in the Museum of Practical Geology a large polished block of green Serpentine, from the intercalated limestone beds of the Laurentian system at Grenville, containing the oldest known organic remains. The minute structure is only visible under the microscope, but drawings to illustrate this structure accompany the specimen.

Sir Charles Lyell then referred to the temperature of the Bath waters—117 deg. to 120 deg. Fahr.—as unexceptionally high, allowing for the great distance of Bath from the nearest region of recently extinct volcanoes and of violent earthquakes; adding that we may well suppose that England was often more rudely shaken than now; and such shocks as that of October last, the sound and rocking motion of which caused so great a sensation as it traversed the southern part of the island, and seems to have been particularly violent in Herefordshire, may only be a languid reminder to us of a force of which the energy has been gradually dying out. Judging from the lines of fault or displacement of the rocks, as laid down in the Ordnance map, the Bath springs, like most other thermal waters, mark the site of some great convulsion and fracture which took place in the crust of the earth at some former period, perhaps not a very remote one, geologically speaking. With respect to the discovery of cæsium, rubidium, thallium, and indium, it is impossible not to suspect that the wonderful efficacy of some mineral springs, both cold and thermal, in curing diseases, which no artificially-prepared waters have as yet been able to rival, may be connected with the presence of one or more of these elementary bodies previously unknown; and some of the newly-found ingredients, when procured in larger quantities, may furnish medical science with means of combating diseases which have hitherto baffled all human skill. Sir Charles illustratively stated that the spring which rises through a lode in the Wheal Clifford Copper-mine is hardly less copious and somewhat hotter than those at Bath; and, in spite of some facts which seem to point the other way, Sir Charles believes in "a relationship between the action of thermal waters and the filling of rents with metallic ores"—between hot springs and mines; and that, although the springs are generally barren of metallic bodies, it is because in their ascent they have precipitated them in veins on the walls of their channels. Another function ascribed to hydro-thermal processes is the metamorphism of sedimentary rocks, produced, not by intense heat, but by a less raging subterranean furnace aided by water—a moderate opinion supported by the Roman aqueducts at Plombières, showing that hot mineral springs, constantly dropping on various kinds of stone, may effect chemical changes never before suspected. The force of the action of hot springs in the interior of the earth is incalculable. To it may be owing the upheaval of strata which, as evidenced by marine shells, is nowhere so obvious as in Wales, where marine shells were in one place upheaved 1360 feet above the sea-level.

THE GLACIAL PHENOMENA IN NOVA SCOTIA.

The most striking physical feature of this whole region, says Professor B. Silliman, jun.—next, perhaps, to the uptilted state of the slatey rocks—is the universal evidence of a high degree of glacial action, which has so worn down and polished the rocks that their edges resemble the leaves of a book which has been cut with a dull knife in the binder's press, in a direction at right angles to that of the leaves. Over very considerable areas the glacial scouring has been so thorough that nothing whatever is left on the rocks but the grooves and striæ which accompany their polish. In other cases the glacial drift is seen, composed of angular, rarely rounded, fragments of quartzite and clay slate, imbedded in a tough clay, resting on the surface of the polished rocks. This detrital matter is auriferous, but the large amount of coarse, angular fragments of rocks would render it very difficult to wash, even when it occurs in situations where water could be conveniently obtained for sluicing.

GLACIERS IN SCOTLAND.

At the Geological Society a paper, by Dr. J. Young, has been read, in which he adduced evidence for his belief that Glaciers formerly existed in the high grounds in the south of Scotland. The heights bordering the counties of Peebles and Dumfries were stated to contain well-preserved remains of a group of glaciers belonging to a later period than the boulder clay, and some of which have been already alluded to, by Mr. Geikie and Mr. Chambers. Dr. Young grouped the several hills into three ranges—the Broad Law range, the White Coomb range, and Hartfell—from which certain glaciers formerly descended into the valleys; and he further divided the glaciers into two classes, which he terms respectively the "social" and the "solitary." He described the form and extension of the masses of detritus, which he considered to be glacial débris, contrasting their characters with those of the patches of boulder clay occurring in the neighbourhood. Many indications of glaciers are shown to be much obscured by the prevalence of peat in the district; but in addition to the moraine matter, smoothed surfaces and "roches moutonnées" are occasionally seen.

GREAT HEIGHTS AND DEPTHS.

Sir Roderick Murchison, in his sectional address to the British Association, passing in review the great geographical discoveries of the past fourteen years and now in progress, said—"The extreme height of the Himalaya having been estimated to be upwards of 30,000 ft., we thus learn that the northern frontier of British rule in India exceeds in altitude the loftiest peaks of the Andes by about the whole height of the highest mountain in Britain. It had been supposed that some depressions in the ocean would be found to balance in depth the extremest heights of land, and this anticipation has been exceeded, for soundings in the South Atlantic, between America and Africa, have shown depths of more than 40,000 ft. If these measurements be reliable—for there is some reason to doubt them—the depth beneath the surface of the sea at certain points far exceeds the heights of the loftiest mountains above it. Another and still more startling result of modern research is the fact that, in dredging the bottom of the North Atlantic Sea, living star-fish were brought up from a depth of a mile and a-half, and were alive, even preserving their colour, when examined on the spot by Dr. Wallich."

PROGRESS OF GEOLOGICAL RESEARCH.

Professor Phillips, in his sectional address to the British Association, has observed—"The age of geological discovery is by many persons thought to have passed away with Hutton and Werner, Humboldt and Von Buch, Smith and Cuvier, Conybeare and Buckland, Forbes and De la Beche; and they regard as almost final the honoured researches of Sedgwick and Murchison and Lyell. Yet in this very district (Bath) the most carefully examined, perhaps, of all the richly fossiliferous tracts of England, our friend Mr. C. Moore is finding a multitude of interesting forms of life of the later triassic age, and is thus enriching, in an unexpected manner, the catalogue of fossils in Britain. Nor is the practical application of our science less actively exercised. In this very district Mr. Sanders has just completed that admirable survey of the strata on the large scale of four inches to a mile, and showing every field, which is suspended before you. Sir R. Murchison has informed us of the further proof of the extension of coal under the permians of Nottinghamshire; and at this very meeting we receive through the same channel, from Mr. M'Kenzie, the news of the finding of an additional bed of coal in Australia, 30 miles from any former known site of coal, the bed being 38 feet thick and of good quality.

"Nothing is better settled than the series of great events in our geological history; yet even now we are rejoicing over the large addition made to this history by the discovery of the richly fossiliferous beds of St. Cassian and Kössen, by which the triassic fauna is enlarged, and the means of comparing palæozoic and mesozoic life augmented by some hundreds of forms, including some genera of the older, and others of the newer systems. The director of the National Survey has decided to give to these strata in England and Wales a distinct colour on his map and a definite name.

"Among the facts put in evidence by geology regarding the former condition of the land and sea, none are so convincing of great change and systematic diversity as the remains of plants and animals. By appeals to these innumerable witnesses conclusions of much importance are maintained, touching the greater

warmth of the carboniferous land and the colder climate of the later cænozoic seas. By the same testimony it appears that over every part of the earth's surface, in every class of organic life, the whole series of created forms has been changed many times. Have we measured these changes of climate and assigned their true physical causes? Have we determined the law of the successive variations of life, and declared the physiological principles on which the differences depend? No! The variations of climate must be further investigated, the limits of specific diversity more surely defined, before we can give clear answers to these critical questions.

"Late researches, partly archæological and partly geological, both in England and France, have been held to prove the contemporaneity of man and the mammoth in the northern zones of the world. Have we, then, been too confident in our belief that the human period was long posterior to, and strongly marked off from, that of the cavern bear and the woolly rhinoceros? Did the races of hyæna and hippopotamus remain inhabitants of Europe till a comparatively modern epoch, or was man in possession of the earth in times far earlier than history and tradition allow? The prevalent opinion seems to be that, as variations of the forms of life are extremely slow in existing nature, for every case of considerable change in the predominant types of ancient plants and animals, very long intervals of time must be allowed to have elapsed. If in some thousands of years of human experience no very material change has happened in our wild plants or wild animals, or in cultivated grains, or domestic birds and quadrupeds, it is evident that no considerable changes of this kind can arise from such causes as are now in action without the aid of periods of time not contemplated in our chronology. Estimated in this way the antiquity of the earth grows to be inconceivable—not to be counted by centuries or myriads of years—not to be really compassed by the understanding of men whose individual age is less than a century, and whose histories and traditions, however freely rendered, fall short of a hundred centuries. The whole human period, as we have been accustomed to view it, is but a unit in the vast sum of elapsed time; yet in all those innumerable ages the same forces were seated in the same particles of matter; the same laws of combination prevailed in inorganic and in living bodies; the same general influences resided on the surfaces or governed the masses of the planets in their ever-changing paths round the sun. All natural effects are performed in time, and when the agency is uniform are in proportion to the time. And though the agency be not uniform, if the law of its variation be known, the time consumed in producing a given effect can be determined by calculation. Geological phenomena of every order can be expressed in terms of magnitude, as the uplifting of mountains, the deposition of strata, the numerical changes of the forms of life. The time required to produce these effects can be calculated, if we know at what rate in time, whether uniform or not,

they were produced; if we know, not the true rate, but the limits within which it must have operated, the result of the calculation will have a corresponding uncertainty; if we have no knowledge of the rate, calculations are out of the question.

"In applying this general view to the history of the earth, philosophers of eminence in physical science have employed different considerations and obtained a variety of results. The conclusions of two eminent mathematicians which have lately appeared may be cited with advantage. A careful computation by Professor W. Thomson, on selected data, which determines the rate of cooling of earthy masses, assigns 98,000,000 years for the whole period of the cooling of the earth's crust from a state of fusion to its present condition; so that, in his judgment, within one hundred millions of years all our speculations regarding the solid earth must be limited. On the other hand, Professor Haughton finds from the *data* which he adopts, 1018 millions of years to have elapsed while the earth was cooled from 212 deg. Fahrenheit to 122 deg. Fahrenheit, at which temperature we may suppose the waters to have become habitable; and 1280 millions of years more in cooling from 122 deg. to 77 deg., which is assumed to represent the climate of the later Eocene period in Britain.

"Computations of this kind cannot be applied, except on the large scale here exemplified, and they lose all their value in the eyes of those who deny the general doctrine of a cooling globe. Much as these periods exceed our conception, they appear to be in harmony with the results of astronomical research, which contemplates spaces, motions, and cycles of periods too vast for words to express, or numerals to count, or symbols to represent. The greatest difficulty in obtaining trustworthy results as to elapsed time is found where it was least expected—among the later cænozoic deposits from rivers and lakes, and on the variable shores of the sea. This is the more disappointing, because within this period falls the history of the human race. Great physical change is the inevitable antecedent to extensive glaciation and abundant dissolution of ice round the mountains of the north. Astronomical vicissitudes returning in cycles of long duration, changes of level of the land, expansions and contractions of the sea, deviations of the currents of the ocean, alterations in the prevalent direction and quality of the winds—whichever of these causes we assume, and however we combine them, it is evident that we are appealing from the existing order of nature and the present measures of effect in time to some other combination of natural agencies, some other standard of physical energy. The conclusion is obvious. Inductive geology refuses to accept definite periods for phenomena produced under conditions not yet really determined."

FOSSILS OF THE CAVE OF BRUNIQUEL.

PROFESSOR OWEN has described to the Royal Society a very large and valuable collection of Fossils, Animal and Human, from

a cave in France, of undoubted authenticity, and positively contemporaneous. The fossils were brought from the Cave of Bruniquel, in the department of Tarn et Garonne, which, in 1863, was first explored by the proprietor, Vicomte de Lastic St. Jal: he obtained from it numerous specimens of remains of animals, flint implements, bone implements, fashioned and carved by means of the flint knives; and, finally, what the Vicomte believed to be human remains, all imbedded in the *breccia*. On receiving a letter to this effect, Professor Owen proceeded in January, 1864, to Bruniquel, explored the cavern, observed other human remains *in situ;* and determined among the collection of fossil animals, the remains of a reindeer and of two kinds of extinct deer, a few remains of red deer, the extinct *Bos primigenius*, and many other species. About 80 per cent. of the beasts killed for food by the primitive inhabitants of the cavern consisted of a large variety of the reindeer. The Vicomte communicated with the French Government, who treated his communication with neglect. He then addressed a letter to the British Museum, when Professor Owen visited the cave, and satisfied himself of the value of the discovery. Meanwhile, the visit of Professor Owen stimulated the French authorities, and Professors Milne-Edwards and Lartet were despatched on a commission of inspection. They also recognised the value of the discovery; and presently an offer was made from the French Government slightly outbidding that which Professor Owen had made. The Vicomte de Lastic St. Jal honourably adhered, however, to his verbal treaty to the Professor. This large collection of fossils—some 1500, many still imbedded in the calcified mould of mud in which they were found, beneath the stalagmite—is now deposited in the British Museum; and the history of these specimens is being carefully deciphered by Professor Owen, who will, it is understood, find in them materials for more than one contribution to the history of fossil man.

This communication described the cavern and the human remains; a calvarium, the back part of a cranium, and the jaws and teeth of adult and young individuals were specified. The cranial characters were compared with those of the skull from the Neander-thal, and that from Engis, valley of the Meuse; also with the crania from the lake-dwellings and ancient burial-grounds of Switzerland, described in the *Crania Helvetica* of Rutimeyer and His. The most perfect calvarium from Bruniquel most nearly resembled, in size and shape, a skull from the Pfalbau of Steinberg. It had not the variety of the great development of the region of the frontal sinuses, as in the Batavian skull figured by Blumenbach in "Dec. ultima LXIII.," and in the Neander-thal cranium. Nor were there any characters indicative of an inferior or transitional type. The evidence of the contemporaneity of the human remains with those of the extinct and other animals was conclusive.—*The Lancet.*

Two Fragments of Human Jaws have been discovered, by

MM. Garrigou, Martin, and Trutat, in a cave at Bruniquel, in company with those of the reindeer, antelope, rhinoceros, goat, horse, wolf, dog, fowls, a large bird, and two species of fishes. The reindeer is stated to be characteristic of the age of the cavern. In relation to the four divisions established by M. Lartet for the quaternary epoch, it is considered that the filling up of this excavation may be referred to the third palæontological epoch. The presence of cut flints, broken and worked up bones, arrows, &c., as well as the large quantity of charcoal disseminated at various depths throughout the cavern, are said to be amply sufficient to prove the existence of man in those remote geological times, and that he was a contemporary of certain forms of mammalia now extinct. For further details we must refer our geological readers to No. 25 of the 57th vol. of the *Comptes Rendus* of the French Academy of Sciences. Thus, human jaws of the same type (brachycephalic), dating from three different geological epochs, perfectly distinct from each other, have been found, at Aurignac, beside the Ursus spelæus; at Moulin-Quignon, beside the Elephas primigenius; and now at Bruniquel, beside the reindeer.

THE FOSSIL ELEPHANT OF MALTA.

More remains of this animal have been discovered by Dr. Leith Adams, F.G.S., in extensive excavations lately made by him among the cavern deposits and breccias near Crendi. The small size of its teeth, and other characteristics, leave no doubt that it was a distinct species, of pigmy dimensions, and supposed not larger than a lion.

FOSSIL MUSK-OX (OVIBOS MOSCHATUS).

In the valley of the Oise, near Paris, Dr. Eug. Robert has found a portion of the skull of this animal—a most interesting discovery, which has been brought under the notice of the Academy of Sciences in a memoir by M. Lartet. Here is, then, an animal now retired to North America which formerly lived in quaternary Europe. We now know that the reindeer, yet more arctic in its migrations, at the same epoch flourished at the foot of the Pyrenees, and the same may be predicated of other animals now denizens of extreme northern countries. "How," says M. Lartet, "have such changes in the geographical distribution of these animals been effected? Has it been by elective migration from their habitat? or by the progressive invasion of man? or by the gradual reduction of species, condemned to extinction, as has been the case with the great cave bear, the elephant and rhinoceros of glacial times, the great Irish elk, &c.? These questions remain to be solved, and we are still led to repeat what Stephen Geoffroy St. Hilaire said thirty years ago, 'The time of true knowledge in paleontology is not yet come!'"—*Illustrated London News.*

A NEW SPECIES OF PLESIOSAURUS

Has been found by Mr. E. C. Hartsinck Day, between Charmouth and Lyme Regis, in a bed of marl. It is stated to be the most perfect specimen ever discovered on the Dorsetshire coast. It is thirteen feet in length, and exhibits the entire dorsal view of the skeleton, with very few bones displaced. With a large head is associated a beautifully preserved lower jaw, filled with long curved teeth; the cervical vertebræ exhibit well the characteristic pleurapophyses; the dorsal vertebræ and the ribs are, as well as other parts, brought out into strong relief, and even the pelvic bones of the under side are partly shown *in situ;* the tail, though less well preserved, is, as a whole, in position. But the great perfection of the specimen lies in the completeness of the four limbs, or paddles, of which not only are nearly all the numerous bones preserved, but they are all, except a few of the ultimate small ones, perfectly undisturbed from their original arrangement and relative position. This magnificent specimen has been purchased by the authorities of the British Museum.

GREAT DISCOVERIES OF COAL IN BRAZIL.

At the Manchester Geological Society, an announcement has been made by Mr. John Plant, of the Salford Museum, respecting the discovery of three extensive coal-fields in Brazil. Mr. Plant said that his brother, Mr. Nathaniel Plant, was the State geologist in Brazil, and he had lately forwarded a description of one of three coal-fields, which were the first that had been discovered in Brazil. Mr. N. Plant, in 1862, fitted out an expedition to the districts of Rio Grande do Sul, and there discovered a large coal-field, which had been named the Candiota, extending over about 150 square miles. The second was on the Rio Ratos, extending over about 50 square miles; and the third was in the province of San Catharina, extending over about 80 square miles.

THE NILE.

Mr. John Hogg, F.R.S., has read to the Royal Society of Literature papers "On the Knowledge which the Ancients possessed of the Sources of the Nile," and "On some old Maps of Africa, in which the Central Equatorial Lakes are laid down nearly in their true positions, and in several of which Maps a large Lake is placed near the Equator, with great accuracy." "Many geographers," says Mr. Hogg, "to whom these maps are unknown, have erroneously concluded that none of these great lakes were known to exist." It will, however, be seen from Mr. Hogg's memoir, that much of Equatorial Africa had been long known to the Portuguese colonists, who endeavoured to keep to themselves their knowledge of that fine and fertile country, in order to prevent any interruption of their commerce with black and white goods—*i.e.*, slaves and ivory. Mr. Hogg, allowing every praise to the intrepid explorers, Captains Speke and Grant, for their discoveries in those regions, and especially for their gallant passage through Africa from Zanzibar, on the Indian Ocean, to the mouths of the Nile in the Mediterranean, shows, in fact, that there are many important problems to be yet solved as regards the geography of the coasts of the equatorial lakes—the rivers flowing into and issuing out of them, as well as the mountains and high lands there supposed to extend themselves. Mr. Hogg points out, in respect of the actual discovery of the sources of the Nile, that the river Kitangulé, and the neighbouring but more western "stream called 'Ingézi Kagéra,' as far as is now known for certain, being feeders of the Nyanza Lake, are two of the sources or head streams of the White Nile;" and also that "the only other head streams of the Nyanza, as yet partly known, are the river Muingwira and Jordans Nullah, at its extreme southern creek."

ANTIQUITY OF MANKIND.

Mr. W. Pengelly has read to the British Association his researches "On the Changes of Relative Level of Land and Sea in South-west Devonshire in Connexion with the Antiquity of Mankind," leading him to the conclusion that there are proofs of human existence in times of higher antiquity, not only than that of the cavern bone-bed but that of the Betula narra bed on Bovey plain. Man, he says, has witnessed an Arctic flora in Devonshire, has seen engulfed rivers carry into caverns their osseous deposits, and in times much less ancient he may have collected shell-fish on the old sea-beaches now 30 ft. above the reach of the highest tide, and hunted the mammoth in a forest over which our largest ships of war now ride at anchor. Mr. Pengelly, in conclusion, pointed out various remains of articles, apparently of human workmanship, found deep in the soil of bone-caves and other places, which proved the vast antiquity of man. Mr. Evans was convinced that the flint produced was the work of man, and not of nature. It had evidently been fashioned into its existing shape by blows from some instrument such as a hammer; there were distinct marks of five blows.

Dr. Symonds said he had visited the district in company with Sir Charles Lyell and Colonel Wood, and their conclusions were entirely in accordance with those of Mr. Pengelly. Strong confirmatory evidence of the truth of Sir Roderick Murchison's theory, promulgated many years ago, that the space between the Severn and the Dee was at one time a portion of the sea, had been discovered at Evesham. These interesting discoveries were recently made in the same locality in the clay itself, and in the gravel had been found the remains of extinct animals, such as the mammoth and the Irish elk. A skeleton of a man had also been discovered, which in all probability was that of a Roman soldier, as

his sword was found by his side; and also a very beautiful golden ornament, which he (Mr. Symonds) had in his possession.

Of kindred interest was the President's paper upon the Measurement of Geological Time by Natural Chronometers—such as streams wearing away their channels, or depositing sediments; formation and growth of peat moor; the filling up of lakes; and the accumulation of detritus in conical mounds, as that at La Tinière on the Lake of Geneva; this has been cut through to between 20 and 30 ft. M. Merlot infers from its examination that at three successive epochs the actions of the torrent spread the reliquiæ of human occupations over the growing delta of La Tinière, and that the epochs may be approximately calculated at 1600, 3800, and 6400 years ago. He refers these dates to particular points in the "Roman," "bronze," and "stone" periods, so that the earliest trace of man in this delta is between 6000 and 7000 years old. No stone implements occurred in this mound. The age of the whole mound is estimated at 10,000 years. Mr. Lubbock recommended a small grant from the Association to enable M. Merlot further to investigate the "Roman Layer."

The Antiquity of Man is the subject of two papers read at a meeting of the French Academy of Sciences, and reported in *Comptes Rendus*, Vol. lviii., No. 70. M. Husson, after reporting his researches in the neighbourhood of Toul, in the Alpine diluvium, comes to the conclusion that man has not preceded that deposit. In another paper MM. Garrigou and Filhol advance reasons for proving that, as the reindeer and man have been proved to be contemporaneous in the centre and south of France during the diluvial epoch, so also the cave bear (*Ursus spelæus*) must have existed at the same period. They state that there is sufficient evidence that the bones of this animal which are found show marks of the handiwork of man, having been formed into spoons, hammers, and other tools, made with a certain amount of care. The peculiarities of the fractures of these bones have been carefully studied by the above-mentioned eminent observers.

CRANNOGES, OR LAKE DWELLINGS IN IRELAND.

MR. KINAHAN has discovered, far below the present level of Lake Loughrea, proofs of the existence of Human Habitations, and other Lakes have long been spoken of as "enveloping with their waters the 'round towers of former days,' which the fisherman, while strolling of an evening along the banks, beholds in 'the waves beneath him shining.'" The crannoges consist of circles and rows of oak piles, and regularly-placed flat stones. Many bones of edible animals, and of large dogs, were long since found, besides bronze and brass ornaments and implements; and, what is very notable, as tending to show how lately such crannoges may have been used as human dwellings, even a brass crozier, inlaid with silver, a battle-axe, a gun-barrel, and a hammered iron vessel. Dwellings would appear to have stood round a common fire in these crannoges.

Similar discoveries in Ireland, in 1863, were announced and detailed in the "Column for the Curious," in the *Illustrated London News.*

THE STONE RECORD.

COLONEL GREENWOOD has addressed to the *Athenæum* the following interesting note:—

"A creator without a creation is scarcely more contradictory than a creation without creatures. And reason and analogy teach us that before the *first* strata were formed on this globe, its land, air, and waters must have teemed with life. As strata result from slow aqueous erosion and denudation, thousands of years or thousands of ages must have passed during the formation of the *first* strata; and it is as contrary to the Mosaic account as it is to all reason and analogy, to suppose that the Almighty Creator should have left his magnificent work, this glorious globe, to swing through space tenantless for ages. What evidence have we that land animals of the highest order did not exist from the first? Why, that we do not find fossils of *land* animals in *sea* strata. This argument is, as I have said, as childishly absurd as if Columbus had told us that America had no *land* animals on it, because he had dredged the *sea*, and had found no remains of them. *Tarde magna proveniunt*, but it is satisfactory, *at last*, to find Sir Charles Lyell at Bath saying that he agrees with Mr. Darwin that the stone record is fragmentary and incomplete. But, on this fact, and *on the reasons of this fact*, is founded a main argument, which runs through the whole of 'Rain and Rivers,' in which a chapter is headed, 'Man may have existed in the Silurian Period.' This was published in 1857, long before 'The Origin of Species,' or the French river-terraces, or the Danish shell-mounds, or the Swiss lake-villages, or 'The Antiquity of Man' were heard of. The two great men, however, have taken one step in the right direction. But they will have to take a great many more."

FLINT IMPLEMENTS.

THE *finds* and contributions during the past year have been numerous and important.

Mr. Prestwich has read to the Geological Society a paper "On the Flint Implements of Abbeville," illustrated by numerous specimens and a large coloured section of the site of the discoveries of M. Boucher de Perthes, which Mr. Prestwich has explored: thus he was able to explain fully the geological history and position of the remarkable flint implements and animal remains there found, whereby he himself was gradually and thoroughly convinced of their genuineness and antiquity. He expressed his own conviction of the difficulty of determining the age of these implements, since the nature of river action is so variable; and therefore the thickness of the deposit does not afford the clue that thickness does in our great rock formations. He referred to, and commented on, an interesting series of sections of the valley of the Somme, exhibiting its supposed features at the times of the formation of the high-level valley-gravels and their emergence, and at the time of the formation of the lower-level valley-gravels; comparing them with a section of the valley in its present state. He especially referred to the convincing researches of Mr. Evans as to these flints being truly works of man by the marks of design; and commented on the probable nature of the climate, as suggested by the remains found of the elephant, rhinoceros, reindeer, &c. In conclusion, Mr. Prestwich expressed his own conviction that we are not yet in possession of sufficient data to speak definitely of the age of these flint implements, and stated that he "was almost satisfied that the evidence we have does not warrant the extreme length of time so frequently supposed." He still adhered to his opinion, stated in 1859, that the evidence, as it then stood, seemed to him "as much to necessitate the bringing forward the extinct animals towards our own time as the carrying back of man to the geological times."

The discovery of a great quantity of Flint Implements in the lands of La Claisière, in the department of the Indre-et-Loire, by Dr. Léveillé, has been announced at a meeting of the French Academy of Sciences. Very few of the specimens were polished, but a block, which it is supposed was used for the formation and finishing off hatchets, has been discovered. The land which contained these relics is situated on the summit of a plateau separating the valley of La Claise from that of La Creuse. The soil is principally clay mixed with silica. From the great number and variety of forms of hatchets, knives, spear-heads, and tools found, the spot has been quaintly termed an *atelier*.

Weapons of Stone and Bone, found in caverns in the department of the Gers, together with remains of deer and other animals, have been presented to the French Academy of Sciences by M. Quatrefages, in the name of MM. Filhol and Garrigou. It is the first time that monuments of the age of stone have been found in such great numbers in the south of France. The owners of these weapons, perhaps contemporaries of the builders of the lake habitations, appear to have made their asylums in caverns. Silex seems to have been rare amongst them, since nearly all the weapons are made of a hard schist analogous to certain rolled flints.

Flint Implements and Fossil Mammalia have been discovered together by Mr. J. Wyatt, at Summerhouse Hill and Honey Hill, near Bedford; by Mr. James Brown, between Southampton and Gosport; and by Dr. H. P. Blackmore, at Fisherton, near Salisbury. In a paper read at a meeting of the Geological Society, Mr. Wyatt described in detail a section, showing that it tended to support Mr. Prestwich's opinion respecting the formation of gravel-beds. In a paper on the other discoveries, after describing the implements from near Southampton, and having shown that their condition is identical with that of the materials composing the gravel capping the adjacent cliff, Mr. John Evans proceeded to review the evidence of the great antiquity of these remains, which rested mainly on the circumstance that these gravel-beds, like those of Reculver, are of fluviatile origin, although now abutting on the sea. In like manner he described the Fisherton implements, and the gravel-pits from which they were obtained. The relation of the high-level gravels (in which the implements were found) to the lower-level gravels of the valley of the Avon was next discussed, and the geological features of the former deposits particularly described; lists of the fossils (including the mammalia and the land and freshwater shells) being also given. Mr. Evans came to the conclusion that the fossils bore evidence of the climate, at the time when they were deposited, having been more rigorous, at any rate in the winter, than it now is; and to this cause he attributed the comparatively greater excavating power of the early post-pliocene rivers.

Flint Implements, discovered in a deposit near Stroud during the excavation for a reservoir, have been reported at a meeting of the Geological Society by Mr. E. Witchell. About two feet from the surface he found a deposit of tufa, containing land-shells with a few fresh-water bivalves, and in it he subsequently discovered several flint flakes of a primitive type, and in the overlying earth a few pieces of rude pottery. As the deposit is situated on the spur of a hill nearly separated from the surrounding country by deep valleys, and as Mr. Witchell considered it to be comparatively recent, he concluded that it had been formed in a pond or lake, which had been caused by a landslip from the higher ground, producing a dam that stopped the downflow into the valley of the water of the neighbouring springs.—*Illustrated London News.*

GEOLOGY OF THE SOUTH-WEST OF ENGLAND.

Mr. C. Moore has delivered to the British Association an address on the Geology of the South-west of England, illustrated by a map prepared by Mr. Sanders. Mr. Moore stated that he had discovered a new kind of clay, or rather a clay that had not been previously found, in the district or neighbourhood of Frome; and out of a cartload of it he had been able to obtain more than a million of organisms, in addition to twenty-nine types of mam-

malia and various kinds of reptilia. He had discovered in these beds many genera that had never been previously recognised; he had succeeded in obtaining over 70,000 teeth of one kind of fish alone in the rhetic bed. Mr. Moore then made some observations with regard to the ironstone that is to be found in the neighbourhood. One landed proprietor held 40,000 acres of land, which for agricultural purposes was useless, but which contained ironstone throughout its whole extent. Multiplying 40,000 acres by 30,000, the quantity of ironstone might be approximated; and its quantity converted into iron, and sold at the present market price, would more than pay off the National Debt. Mr. Moore produced specimen stones from the neighbourhood of Bath, each containing fish. When one stone was broken open, not only was the cuttle-fish discovered, but the inky fluid—the sepia—was discovered as in a fish of the same kind that might be taken out of the sea at the present day. He then produced a specimen of a fish about the size of a salmon, of six or seven pounds' weight. So perfect was it in shape that but for its colour it might have been handed by mistake to the cook to dress; yet it must have been millions and millions of years since it lived.

EARTHQUAKE AT ST. HELENA.

There has been read to the Geological Society a paper "On the Recent Earthquake at St. Helena," by Governor Sir C. Elliot, K.C.B. This earthquake, which is stated to be the fourth that has occurred during the two centuries that we have been in the occupation of the island, occurred at about 4 h. 10 m. A.M., on July 15th; and in this paper Sir C. Elliot described the nature of the shock and the circumstances attending it.

EARTHQUAKE IN MEXICO.

Mexico was visited by a terrific Earthquake on the 3rd of October last. In the capital the oscillations, which were first from north to south, and then from east to west, were followed by that trembling movement which renders such phenomena so formidable. Some old buildings in the suburbs fell to the ground, but no loss of life took place. At Puebla the consequences were more serious. A letter from that town, dated the 3rd, states that the earthquake lasted from twenty-eight to thirty seconds. The cupola and a part of the tower of the church of San-Augustin, the sculptured shield in front of the palace, a portion of the convent of San Juan de Dios, and a large number of houses, all fell to the ground. Seventeen French soldiers were killed or wounded, and twenty-nine of the inhabitants were taken to the hospital, more or less severely hurt. The earthquake was felt with more or less violence on the whole line of the route from Vera Cruz, especially at Acultzingo, Palma, Orizaba, Cordova, and La Soledad. A communication from Tehuacan mentions that great damage was done

in that town. Nearly all the belfries in the place and the Town Hall lie in ruins, and a large number of houses were in a tottering condition. At Orizaba a church tower recently erected was thrown down.

EARTHQUAKES IN ENGLAND.

On January 2, 1864, three slight shocks of Earthquake occurred at Beeston, near Nottingham—viz., at 1 h. 18 m., A.M., 1h. 35 m. 20 sec., and at 1 h. 50 min. 10 sec. Each shock was accompanied by a faint noise, apparently in W.S.W., not unlike that of a distant railway train. The noise lasted 2 sec. with the first and second shocks, and only 1½ sec. with the last shock. The earthquake pendulum moved in the direction from N. to S., but the motion was small. The shock at 1 h. 35 min. 20 sec. was the strongest. The sensation of motion, however, was feeble, being more like a tremble than actual movement. The night was cloudless, foggy; wind, N.N.E., the air perfectly calm, with severe hoar frost, the temperature being 20·2 deg. in the air, and only 17·3 deg. on the grass.—*E. J. Lowe, Observatory, Beeston.*

On August 21, the town of Lewes, Sussex, was visited in the morning with a severe shock of earthquake. Mr. Wingham writes from the Crown Hotel: "I was awakened by a very loud report, resembling an explosion, and the oscillating of my house, together with my bed and all articles in my room, which were kept in a state of vibration for quite a minute after the shock. I immediately jumped out of bed, turned on my gas, and by my clock the time was 1.27. I looked out of my window, and all was still, fine, and starlight. The same effect is described by others sleeping in my house. I have heard to-day from many persons of their alarm—several of them getting up to discover what was the matter, all being very much frightened. Since eight o'clock to-day we have had thunder, and a quantity of rain has fallen. It is now quite fine."

In the *Times*, September 20, a Correspondent writes from Aford House, Headley, near Hazlemere—"The inhabitants of this village were all surprised last night by a violent shock which occurred at 10 minutes to 10. The whole house in which our party were staying was shaken, and there was a sound as if a heavy body had fallen from a height on to the floor of the room above our heads, like somebody falling out of bed. On my arrival at the inn where I slept, some quarter of a mile distant, I learnt that the same phenomenon had been experienced there, and with such violence as to cause the glass, &c., on the sideboard to ring. This morning we have heard several other accounts of a similar nature from persons living in different parts of the village. A similar shock took place on the morning of Wednesday, the 7th inst. Several of the villagers were shaken in their beds by that of last night. As we cannot account for these shocks otherwise than by attributing them to an earthquake, I venture to send this account in case others of your readers should have been similarly affected. There was heavy rain in the night and a mysterious lurid appearance in the sky at sunrise, and thunder-clouds floating about. This village is seven miles west of Hazlemere, at the foot of Hind Head, in Hampshire."

VOLCANO IN JAVA.

In January last an Eruption of the Merapi and Kloet took place. All the towns in the neighbourhood were buried in volcanic ash and lava; the former was even carried to places eighty miles distant. The little village of Blitar was destroyed. Several sugar and tobacco crops ruined. Some 350 were lost.

NEW VOLCANOS IN THE MOON.

Messrs. T. W. Webb and W. R. Birt, while studying the surface of the Moon on the 18th of last May, discovered two new small Craters in the single volcanic crater to which the name Marius is given by MM. Beer and Maedler, and who, in speaking of the crater as figured in their map, say that the interior is quite simple, which certainly indicates the absence of terraces and secondary craters. Messrs. Webb and Birt, therefore, infer that the two new craters have been formed within the last thirty years.

FINE FOSSIL.

A remarkably fine fossil head of *Elephas primigenius* has been found in the Pleistocene sands and clay at Ilford. The upper molars remain in place, and both tusks have also been preserved, one still in the socket, but seemingly having been twisted round by the weight of the head, when the fleshy tissue of its attachment had decomposed, and before the skeleton was finally embedded in the soil. The tusks are of spiral curvature, and measure along their median line above 10 feet 6 inches in length. No such perfect skull of the true Mammoth has ever been found in England, nor anything comparable with this important example, so far as we are aware, except it may be the fine fossil elephant in the Chichester Museum, a specimen of which we have heard, but have not seen. The present specimen in scientific value can only be classed with the famous one at St. Petersburg, and we are glad to add that it has, by the promptitude of Mr. Waterhouse and the Trustees, been obtained for our National Collection; while to Mr. Davis, who was despatched by the Museum authorities to extricate this gigantic fragile mass from the rough loose earth of the quarry, too much praise cannot be given for the successful manner in which he has accomplished that difficult task."—*Athenæum.*

Astronomical and Meteorological Phenomena.

SPECTRA OF SOME OF THE HEAVENLY BODIES.

A PAPER has been communicated to the British Association, by Dr. W. A. Miller and Mr. Huggins, possessing remarkable interest from the extraordinary discoveries announced; and especially for the information obtained by Mr. Huggins, by spectral analysis, of the constitution of certain Nebulæ. The facts obtained were of three classes: those relating to the planetary spectra, those of the double stars, and those which were Mr. Huggins's entirely, of the spectra of nebulæ. The latter are the most remarkable of any results yet obtained. There are various kinds of nebulæ; but their general faintness is such that, but for the singular peculiarity of their light being nearly monochromatic, or but one degree of refrangibility only, it would be impossible to examine their spectra at all. The nebulæ which Mr. Huggins had observed are six of these planetary nebulæ, besides about an equal number of nebulæ with a more or less distinctly brighter luminous centre. The intent of the inquiry is, what is the condition of the nebulous matter? Is it highly gaseous, expanded to an enormous area in space, or is its luminosity caused, as some have considered, by myriads of solid masses coming into collision, and thus that their heat and light are revealed by the telescope? Mr. Huggins's observations tend to show that in some, at least, of these nebulæ there is no solid matter at all. Some of these bodies noticed by Herschel are very uniform in illumination, and even by Lord Rosse's telescope cannot be made to show any signs of being resolvable into clusters of stars. The nebulæ 37 H iv. in Draco, 6 Σ in Tauri, 73 H iv. in Cygnus, 61 H iv. in Sagittarius, 1 H iv. in Aquarius, and the annular nebulæ in Lyra, have been observed. In 37 H iv. there is one band of maximum brilliancy between *b* and F, about one-third of the distance from *b*, which closely corresponds with the brightest line in the spectrum of nitrogen; and nearer to F is another line near to, but not coincident with, one of the brightest spectral lines of Barium. There is a faint line at F seemingly due to hydrogen. Herschel has stated that the mass of one of these planetary nebulæ, if distant from us as far as 61 Cygni, would fill a space equal in diameter to seven times that of the orbit of Neptune; and hence, were it not that the light was concentrated nearly into a single line, its examination would not be practicable. In the light of these nebulæ there is nothing to indicate, as in the case of the sun, a solid luminous globe behind the luminous photosphere, but the light from them is such as is characteristic of gaseity. When a star occurred in, or was associated with, the nebulæ, a very feeble continuous spectrum was observed. These important investigations have been printed by the Royal Society.

A FALLING STAR,

Seen on the 6th of June, 1864, was thus described by M. Coulvier-Gravier in a communication to the French Academy. It appeared about 9h. 56m. in the morning between the crown and the feet of Hercules, and, proceeding from S.S.E. to N.N.W., disappeared, after a course of 100 deg., in three seconds, between Alpha and the Goat and the bow of Perseus. It was a meteor of the first class, but not so large as the full moon. It maintained its white colour throughout the time, and its train was compact and nearly white. Just before the end of its course the star broke up into three fragments, which still retained their whiteness. At the time of its appearance an intense storm was raging in the southern extremity of the horizon, and the brilliancy of the incessant lightning was diminished by that of the meteor.

A MACHINE FOR CATALOGUING AND CHARTING STARS,

Invented by Mr. G. W. Hough, of Dudley Observatory, U.S., is described and figured by him in the *American Journal of Science*, No. 113. He believes that his apparatus is the first constructed to record accurately, by mechanical means, the right ascension and declination of a star at the same instant. We must refer our readers to the valuable journal for the details of the construction and application of Mr. Hough's instrument.

LARGE FIRE-BALL.

M. LESPIAULT has reported to the French Academy of Sciences the bursting of a Fire-ball on the 24th of September; and in a letter from Mont-de-Marsan, published in the *Gironde*, it was stated that on that day, at 20 minutes past 12 p.m., a fiery globe of the size of a bomb-shell had burst in the vicinity of that town with a violent noise resembling the simultaneous report of 20 pieces of ordnance. This noise lasted ten seconds; the direction of the bolts was from north to south; but the phenomenon could not be observed in all its splendour because the sun was very brilliant, and not veiled by the slightest cloud.

NEW COMETS.

A NEW COMET was observed by M. Bäcker, of Nauen, near Berlin, on Jan. 1, at 283 deg. right ascension and 28 deg. north declination. It presented the appearance of a circular nebulosity, about a minute in diameter, with a small tail. This comet is not the same as the one discovered by M. Respighi, of Bologna Observatory, on Dec. 28, between the constellations Hercules and Lyra.——In the *Morning Herald*, Mr. G. F. Chambers, author of the *Handbook of Astronomy*, gives the elements of the comet discovered by Respighi, as determined by Peters; and, after comparing them with those given by Bessel for the comet of 1810, and

those given by Hind for the comet of 1490, he expresses his opinion that the three are identical. The brightness of Respighi's comet, on Jan. 29, will be eleven times brighter than on the day of discovery, and therefore it may become visible to the naked eye. Mr. Chambers states that on Jan. 22 the comet will be 2 deg. N. of Cygni, a star of the first magnitude; that on Jan. 29 it will pass into the head of Cassiopeia; subsequently into Andromeda; and that after Feb. 1 it will pass with great rapidity into the southern hemisphere.

The Comet of M. Tempel approached very near to the earth on Aug. 8, about the time we passed through the ring of shooting stars. It would have been very brilliant if its light had not been diminished by that of the sun. As it passed between the sun and the earth, in an orbit a little inclined upon the ecliptic, its tail swept through the terrestrial orbit; and, if it had been sufficiently long, would have reached the earth. To do this it must have had a development of fifteen millions of kilometres—not an extraordinary length for a comet's tail. MM. Bruhns and Engelmann followed this comet with the Leipsic refractor till Aug. 15. On July 30 the comet resembled a round nebulosity, and the nucleus was badly defined and eccentric. On the 31st it possessed the light of a star of the fifth magnitude, and was seen with the naked eye. On Aug. 5 and 6, at 2.40 a.m., M. Donati analysed the light by the spectrum apparatus, and perceived several remarkable rays. We learn that he has figured the spectrum in No. 1488 of the *Astronomische Nachrichten*. MM. Donati and Toussaint discovered another comet on July 23, and have published the elements; and on Sept. 11 the former astronomer discovered the third comet of the year.

NEW PLANETS.

The New Planet (No. 79), discovered by the American astronomer, Mr. Watson, on Sept. 19, 1863, has received the name of Eurynomé, a daughter of Oceanus and Thetis, and, according to Hesiod, the mother of the Graces, by Zeus. The same astronomer, it is said in *Les Mondes*, on Jan. 12 last discovered independently the comet found by M. Respighi.

A New Minor Planet (the eightieth of the series), of the remarkable group between the orbits of Mars and Jupiter, was discovered by Mr. Norman Pogson, the Government astronomer of Madras, on the 3rd of May last, in the constellation Scorpio. In brightness it was equal to a star of the $10\frac{1}{2}$ magnitude. Mr. Pogson states that it was very near the place where he discovered Isis, in 1856, and he thinks that very probably the new planet is identical with the one which he found on June 6, 1853, and afterwards missed and never recovered. The planet discovered by Mr. Pogson on Feb. 2 has, by the calculations of astronomers, been determined to be identical with "Freia" (No. 76), discovered by M. D'Arrest, in October, 1862.

A New Planet, discovered by M. Tempel, at Marseilles, at eight P.M. on Sept. 30, has been named after Terpsichore.

WATERSPOUTS.

On Sunday morning, August 29, 1864, about half-past nine o'clock, says a Correspondent in the *Times*, the town of Brighton was visited with a severe thunderstorm, during which a distinct waterspout was visible at sea:—"The storm came over from the westward with an intense blackness of cloud, thunder having been over our heads for about half an hour previously. It reached the east side of the town about half-past nine, and burst with terrific fury almost instantaneously. A few minutes before this took place a dark blue waterspout was distinctly visible about two miles out at sea, which rapidly arose from the water like a thick cloud of smoke from a chimney and joined the dark clouds above. There seemed to be several other smaller connections with the sea, but by this time the atmosphere became so thick and dark that the separation of the clouds and sea was not discernible. The downfall of hail was terrific, the streets being quickly covered with ice. I picked up one piece, which was as large as a sparrow's egg."

The bark *Jane Doull*, Captain Smith, had an exceedingly narrow escape from destruction by a waterspout at sea. She left Bermuda on Sunday the 14th August, and shortly after, the wind having fallen to a dead calm, she came to anchor off the Great Sound. "Next morning a dull rumbling roar could distinctly be heard. We next observed, about five miles from us, a cylindrical column reaching from the sea to the altitude of 500 feet. Around this cylindrical column the wind seemed to be rushing with the force of a volcano. A smaller one, which appeared about this time, was apparently 'swallowed' by the larger one. The great line of black clouds solemnly advanced on each wing of the spout, which dropped down its mighty weight of water on the sea, while the winds madly rushed it towards us. The sea was lashed into great waves; the waters poured, and bubbled, and rose in swaying masses over six feet in height. The awful column advanced. Not one on board the ship but felt the danger, and knew that nothing could save us if it struck the ship. Thank God it burst about thirty yards from us, and the last remnant of water ceased within about 10ft. of the stern."

CYCLONE AT MASULIPATAM.

A Correspondent writes:—"On the night of November 1 we had a most furious gale, with torrents of rain, which brought up the sea upon the place, though we are three or four miles from it. In our compound it was 6 ft. or 7 ft. deep, and carrying everything moveable before it. Our house is well raised, so little came in, but those who were lower had the water in according to their

position; and you may fancy the condition of the poor natives and the Sepoys, who live in mud-walled huts on the ground. The Sepoys' houses were literally swept away, and about 200 men, women, and children perished. It was in the dead of night, which made it more awful. In the large native town the loss can hardly be calculated; but people say 2000. In the Sepoys' lines or barracks alone about 300 bodies were buried. The native town was entirely washed away, and 5000 natives perished."

GREAT STORM AT CALCUTTA.

On October 5th, a terrible storm took place at Calcutta; two hundred ships were blown from their moorings in the Hooghly; some were wrecked, and many driven on shore. There was great loss of life; the huts of the natives were nearly all destroyed; churches were blown down, and the cathedral injured; trees uprooted, and the Botanic Garden destroyed.

GREAT FLOODS AT MELBOURNE.

A Correspondent writes from Melbourne, December 26, 1863:—"Such scenes as for the last ten days we have witnessed in the neighbourhood and suburbs of this city are without precedent in the memory of black or white inhabitant. On Monday, the 14th inst., the weather which had been for some days previously somewhat unsettled, culminated in one of the fiercest and most prolonged gales of wind, at irregular intervals rising to the strength of a hurricane, ever known along the Australian coast. Accompanying the wind was such a deluge of rain that speedily several of our lower streets seemed converted into rivers, and the river Yarra, swollen by the unusual contributions from the Dandenong range of hills, in an incredibly short period overflowed its banks, converted a large portion of our suburbs and of the southern side of the stream into a vast lake, and drove the inhabitants with precipitation from their houses. All the lower lying banks of the river were overflowed to the height of some 40 feet. Melbourne became surrounded by water. Boats plied at first-floor windows; merely the tops of buildings indicated their situation to the eye.

BALLOON EXPERIMENTS.

Mr. Glaisher has read to the British Association the account of the Ascents made by him during the year 1864, which he prefaced by the following observations:—

The Committee on Balloon Experiments was appointed in 1863, for the following purposes:—To examine the electrical condition of the air at different heights; to verify the law of the decrease of temperature; and to compare the constants in different states of the atmosphere. With respect to the first of these objects, no progress had been made with the exception of preparing an instrument and apparatus for the investigation. At the request of the Committee, Mr. Fleeming Jenkin undertook the construction of the best instrument for the purpose, and one was finished towards the end of 1863, but it was constructed to be used with fire; it has

since had to be adapted for water—a constant flow of which is necessary in electrical experiments in balloons. This apparatus Mr. Glaisher was requested by the Committee not to use, as they felt that these instruments, if exerting no influence while the balloon was rising, might, when it was falling, throw considerable doubt on the experiments relating to humidity. With respect to the second of these objects, the verifying the law of the decrease of temperature in different states of the atmosphere, the Committee considered would be best attained by taking as many observations as possible, at times in the year, and at times in the day, at which no experiments had been made, for the purpose of determining whether the laws which hold good at one time hold good at other times of the year, and also to determine whether the laws which hold good at noon apply equally well at all other times of the day. The Committee have always pressed the importance of magnetic observations in the higher regions of the air; the Astronomer Royal suggesting the use of a horizontal magnet, and taking the times of its vibration at different elevations, a method which is seldom practicable, owing to the almost constant revolution of the balloon. To obviate this, Dr. Lloyd suggested the use of a dipping-needle placed horizontally when on the ground, by means of a magnet above it, so that, when in the balloon, the deviation from horizontality might be noticed, and which deviation would be independent of rotary motion of the balloon. The latter method has not yet been tried, Dr. Lloyd wishing some experiments to be made before the instrument was constructed; at Newcastle a very general wish being expressed that very high ascents should not again be attempted, none above five miles had since been made.

Mr. Glaisher then described his several ascents during the year.

The first was from Newcastle, on the 31st of August. The balloon left the earth at 6h. 12m. P.M., with a north wind, and descended at five minutes past 7, at Pittington, near Durham. The decrease of temperature within the first 200 feet of the earth in this ascent was very remarkable, no such rapid decrease having been found in any other ascents. On the ground the temperature was 64°, and by the time 200 feet had been attained, a decrease of 8 degrees had taken place, the temperature being 56°; from this height to 1200 feet, there was but little change, and above this the temperature decreased from 2° to 3½° in each succeeding 1000 feet, up to 7000 feet, when the balloon entered a relatively warmer current of air.

The second ascent, on the 29th of September, 1863, was from Wolverhampton. The gas on this occasion had been prepared in July, expressly for a high ascent intended to have taken place before the Newcastle Meeting, but circumstances prevented this being made, and the gas was obligingly stored in the gasometer by the directors of the gas-works. The balloon left at 7h. 43m. A.M., wind S.W. At 8200 feet there were two layers of clouds below the balloon and very dense clouds above. When at 11,000 feet, the clouds were still a mile higher; there was a sea of blue-tinged cloud below, and peeps of the earth were seen through the breaks. At 13,000 feet, high clouds were still above; but after this they began to dissipate, and at 9h. 38m., at 14,000 feet, the sun shone brightly. Ten minutes afterwards the travellers discovered the Wash at a distance of only ten miles, and were compelled to descend. A south-west gale was blowing, and so strong was the wind that on the grapnels taking the ground near Sleaford, at 10h. 30m., the balloon was rent from top to bottom. In this ascent warm currents were met with at 8000 and 13,500 feet. In the descent a warm current was passed through, extending from 14,000 to 9000 feet. Temperature at the ground on leaving 48°; at time of descent 53°. On passing out of the mist at 3000 feet the humidity declined to 58° at 8000 feet; here there were dense clouds both above and below; at 9000 feet the humidity was 71°; and then the air became suddenly dry.

The third ascent was made from the Crystal Palace, at 4h. 29m. P.M. on the 9th of October. In seventeen minutes it was 7300 feet high, and directly over London Bridge. There were neither warm nor cold currents met with on this day.

The Secretary of State for War having granted permission to the Committee to avail themselves of the facilities afforded in the Royal Arsenal at Woolwich, the ascent of the 12th of January was made from thence. The

balloon left at 2h. 7m. P.M., and in 14 minutes had crossed the Tilbury Railway and was over Hainault Forest; at 3h. 31m. the height of 12,000 feet was attained, when the balloon began to descend, and touched the ground at 4h. 10m. at Lakenheath. On the earth the wind was S.E.; at 1300 feet a strong S.W. current was entered, in which the balloon continued up to 4000 feet, when the wind changed to S. At 8000 feet the wind changed to S.S.W., and afterwards to S.S.E.. At 11,000 feet, fine granular snow was met with; and the balloon passed through snow on descending, till within 8000 feet of the earth. Clouds were entered at 7000 feet, which merged at about 6000 feet into mist. This ascent is the only one ever made in January for scientific purposes.

The fifth ascent was designed to have been made as near the 21st of March as possible, but through adverse weather was deferred to the 6th of April. The balloon left Woolwich at 4h. 7m. P.M. with a S.E. wind, ascending evenly at the rate of 1000 feet in about three minutes, till 11,000 feet was attained at 4h. 37m. It descended in the Wilderness Park, near Sevenoaks, in Kent. Its course was most remarkable, having passed over the Thames into Essex; the balloon, unknown to the aëronauts, must have repassed the river and moved in a directly opposite direction, and so continued till it approached the earth, when it again moved in the same direction as at first. The ascent is remarkable for the small decrease in temperature with increase of elevation. The air at the period of starting was 45½°, and did not decline at all until after reaching 300 feet, after which it decreased gradually to 33° at 4300 feet. A warm current was then entered, and the temperature increased till 7500 feet was attained, when 40° were attained, being the same as had been experienced at 1500 feet. It then decreased to 34° at 8800 feet, and then increased slowly to 37° at 11,000 feet, a temperature which had been experienced at the heights of 8500, 6500, and 3000 feet in ascending.

After the great injury to the balloon on the 29th of September, Mr. Coxwell not considering it safe for extreme high ascents, built a new one, capable of containing 10,000 cubic feet more gas than the old one, so that, if need be, two observers could ascend together to the height of five miles. A new balloon, however, needs trying in low ascents until it proves gas-tight, before it can be used for great elevations; and on June 13, it was therefore started on a small ascent from the Crystal Palace, at 7 o'clock; the sky cloudless and the air perfectly clear, except in the direction of London. An elevation of 1000 feet was reached in 1¼ minute, 3000 feet at 7h. 8m., when the balloon descended to 2300 feet, and then re-ascended to 3400, when, after a slight dip, it again ascended to 3550 feet, the highest point, by 7h. 28m., and then, after some oscillations, began its downward course at 7h. 50m. from 2800 feet, reaching the ground at East Horndon, five miles from Brentwood, at 8h. 14m. The remarkable feature in this voyage being that below 1800 feet elevation there was scarcely any change of temperature until the earth was reached. This fact, of no change in the temperature of the air at the time of sunset, was very remarkable, for it indicated that, if such be a law, the law of decrease of temperature with increase of elevation may be reversed at night for some distance from the earth.

June 20, the balloon left Derby at 17 m. p. 6 P.M.; descended near Newark. June 27, the balloon ascended from the Crystal Palace at 6h. 33½m. the sky cloudy, wind west; descent made on Romney Marsh, 5 miles from the shore.

These several trial trips of the new balloon were made, and it was gradually becoming gas-tight, when its lamentable destruction at Leicester took place.

Mr. Coxwell then made in the old balloon his next and last ascent, on August 29, from the Crystal Palace, at 4h. 6m. The difference between the temperatures of the air and those of the dew-point in this ascent was rather remarkable. The most important points in the past year's experiments are:—That though the law of decrease of temperature under ordinary circumstances in the summer months is pretty well determined, we cannot say such a law holds good throughout the year; nor can we say that the laws which are in force during the day will be in force at night. In carrying out these experiments, Mr. Glaisher said he had freely given up all his leisure, and that Mr. Coxwell had done the same in the most unselfish manner; indeed, had it not been for the generous spirit in which Mr. Coxwell had entered into these experiments, they never could have been made, except at a multiple of the cost that had been incurred.

METEOROLOGY OF 1864.

Results deduced from the Meteorological Register kept at the Royal Observatory, Greenwich, during the year 1864.

1864. Months.	Mean Reading of Barometer.	Temperature of Air. Highest by Day.	Lowest by Night.	Range in Month.	Mean of all Highest.	Mean of all Lowest.	Mean Daily Range.	Mean for Month.	Departure from average of 23 yrs.	Mean Temp. of the Dew Point.	Mean Tension of Vapour.	Weight of Vapour in a cubic ft. of Air.	Mean additional Weight required for saturation.	Mean Degree of Humidity. Saturation=100.	Mean Weight of a cubic foot of Air.	Relative proportion of Wind. N	E.	S.	W.	Mean Amount of Cloud. 0 to 10.	Rain. No. of Days it fell.	Amount collected.
	In.	°	°	°	°	°	°	°	°	°	In.	Grs	Gr.		Grs.							In.
n.	30·044	54·0	14·3	39·7	41·4	31·7	9·7	36·5	−1·8	31·3	·176	2·0	0·5	82	561	4	10	11	6	6·8	10	0·9
b.	29·760	53·8	20·1	33·7	41·5	31·2	10·3	36·0	−2·9	31·3	·176	2·0	0·5	83	557	12	6	6	5	7·8	12	0·8
arch	29·503	58·0	26·9	31·1	49·8	34·3	15·5	41·3	−0·7	36·2	·215	2·5	0·6	83	546	7	9	7	8	6·9	14	2·7
pril	29·915	73·8	33·4	40·4	58·3	40·0	18·3	48·2	+1·7	40·0	·248	2·9	1·0	74	547	7	9	8	6	5·6	4	0·7
ay	29·837	81·0	33·4	47·6	64·8	44·9	19·9	53·8	+0·9	45·6	·306	3·5	1·1	73	538	11	7	7	6	6·3	10	1·9
une	29·792	78·4	42·3	36·1	69·5	49·1	20·4	57·4	−1·7	48·7	·344	3·9	1·4	72	533	4	2	10	14	7·0	9	0·9
uly	29·856	85·6	45·8	39·8	75·3	51·2	24·1	61·8	+0·2	51·6	·382	4·2	1·9	70	529	7	6	7	11	6·4	3	0·3
ug	29·918	88·6	38·1	50·5	72·8	48·5	24·3	59·6	−1·8	47·8	·333	3·7	2·0	65	533	9	4	7	11	5·3	5	1·4
ept	29·777	75·5	40·9	34·6	67·3	49·1	18·2	56·9	0·0	49·7	·357	4·0	1·2	77	533	1	2	12	15	6·2	16	2·8
Oct.	29·684	67·2	37·5	29·7	58·2	44·1	14·1	50·5	0·0	43·7	·285	3·3	0·8	78	539	8	9	7	7	6·8	6	1·1
Nov.	29·626	54·4	25·9	28·5	48·5	35·5	13·0	42·0	−2·1	37·9	·228	2·6	0·5	86	547	5	5	12	8	6·5	13	2·6
Dec.	29·863	53·7	17·3	36·4	42·5	33·7	8·8	38·5	−1·9	34·4	·199	2·3	0·5	86	556	5	9	12	5	7·9	10	0·6
Means...	29·798	68·7	31·3	37·3	57·5	41·1	16·4	48·5	−0·8	41·5	·271	3·1	1·0	77	543	80 Sum	78 Sum	106 Sum	102 Sum	6·6	112 Sum	16·7 Sum

NOTE.—In column 10 the sign + implies above, and the sign — below the average.

EXPLANATION.

The cistern of the barometer is about 159 feet above the level of the sea, and its readings are coincident with those of the Royal Society's flint-glass barometer. The observations are taken daily at 9 A.M., noon, 3 P.M., and 9 P.M.; the means of these readings are corrected for diurnal ranges by the application of Mr. Glaisher's corrections, in the *Philosophical Transactions*, Part I., 1848; and from the readings of the dry and wet bulb thermometers, thus corrected, the several hygrometrical deductions in columns 11 to 16 are calculated by means of Mr. Glaisher's Hygrometrical Tables. *Third Edition.*

The numbers in column 2 show the mean reading of the barometer every month, or the mean length of a column of mercury which balanced the whole weight of atmosphere of air and water; the numbers in col. 12 show the length of a column of mercury balanced by the water alone; and if the numbers in this column be subtracted from those in column 2, the result will be the length of a column of mercury balanced by the air alone, or that reading of the barometer which would have been, had no water been mixed with the air. [*Concluded on next page.*

The Mean Temperature of the year was 48°·5, that of the 50 years ending 1863, is 50°·3, as determined by Mr. Glaisher from all the observations made in the Royal Observatory from January 1, 1814. The mean temperature of the year 1863 was 50°·3, therefore the past year was 1°·8 colder than the preceding. The temperature of the dew-point was 41°·5, being 2°·8 less than in the year 1863. There were on the average of the whole year 3·1 grains of water in the invisible shape of vapour in a cubic foot of air, being 0·3 less than in 1863. The degree of humidity of the air was 77, in 1863 it was 80, complete saturation being represented by 100. On 80 days the preponderating wind was N., in 1863 the number was 61; of East there were 78, in 1863 the number was 55; of South winds there were 106, in 1863 the number was 108; and of West winds 102, in 1863 there were 141; so that in 1864 there were 17 days more North, 23 more East, 6 less of South, and 39 less of West winds than the preceding year. There was less water in the air to the amount of $\frac{1}{15}$th; the air was generally drier. Rain fell on 112 days, in 1863 on 131 days; the amount collected in 1864 was 16·7 inches, in 1863 was 20·0 inches. The average for the year is 25·3 inches, in 1863 the fall of rain was the smallest on record, and was 8·6 inches below the average, and the deficiency in 1864 was 5·3 inches, or together 13·9 inches. The fall of rain in the two years ending December 1864, amounted to 36·7 inches, and is the smallest in any two consecutive years on record.

The year 1863 closed with very fine weather for the season all over the country, and which had continued for several weeks (see the *Year-Book* of last year). At the beginning of January 1864 the weather completely changed, and till the 9th day the weather was exceedingly cold, averaging a daily deficiency of 8¼° of temperature; on the 6th the deficiency was as large as 15°, and exceeded 13° on the 7th, and the temperature on grass at night was as low as 6° and 7°, checking the advance of vegetation. The frost broke up on the 10th, and a period of warm, damp, and foggy weather set in, and till February 3rd there was an average daily excess of 3¼° of temperature. On February 4th a cold period set in, snow fell in many parts of the country, and till the 11th day the deficiency of daily temperature was 7½°; on some days within this period it exceeded 10°; a period of five days followed, ending the 16th, during which the weather was warm; the average daily excess was 6¼° nearly. From February 17th the weather was altogether of a wintry character, with frost, snow, and sleet at all parts of the country. The wind blew from the north and east, and the average daily deficiency of temperature for 16 days, ending March 3rd, was 4½°. From March 4th to the 15th the weather was generally warm, there being an excess of 2¼° daily; and from March 16th to the end of the quarter there was a daily deficiency to the average amount of 2°. During these three months there was an unusual number of alternations in temperature and change of weather from frost to thaw.

This cold and changeable weather continued to the 8th of April; the average daily deficiency of temperature from March 16 to April 8th was 1°·8. A warm period set in on the 9th, and continued with slight exception to May 22nd. The average daily excess of temperature for these 44 days was 3¼° nearly. From May 23rd to the end of the quarter the weather was cold, with the exception of the few days between June 6th and 10th, and the deficiency for the 39 days, ending June 30th, amounted to 2¼° nearly daily.

At the beginning of April the weather was cold and bleak; but little progress could be made with field work. On the 9th of April the change in the weather was marked, and farmers took advantage of the change, and at the end of the month all over the country the crops were reported as being in a good state.

At the beginning of May rain fell frequently, and the cereal crops improved, and everywhere wore a healthy appearance. The change in the weather from heat to cold on the 23rd, with frosts at night during the last week in May, somewhat checked the good appearance of those crops, but upon the whole they were satisfactory.

During the month of June the wind was from the east. It was too cold; there was a deficiency of rain; the weather was not generally good for agricultural purposes, and different reports from different parts of the country were received, some of them not good, and upon the whole the probable yield of this year's cereal crops would seem to fall short of that of last year.

The month of June opened with a continuation of the same weather which had prevailed for the previous 39 days, with somewhat increased intensity; the deficiency of temperature to the middle of July being as large as 3° daily on the average. On the 17th July a warm period set in and continued for 25 days, and the daily temperature was in excess to 3¼°; this was succeeded by 20 days of very cold weather, viz., from 9th August to 28th August, whose average daily temperature was 4° in defect; and it is remarkable that this deficiency of temperature fell on the nights only, the days were of their average warmth, but the nights were very cold, causing the extremes of temperature to range from great heat by day to almost frost at night, and quite to frost on vegetation. A period of 12 days followed of warmth, the average daily temperature being 2¾° in excess; then the 10 days from September 10th to 20th, the temperature of the air was daily 2° below their average values, and the last 10 days of the quarter were in excess to 1¼° daily; and from this time to the end of the year there was generally a deficiency of temperature both by day and night, particularly in the months of November and December.

The mean temperature of January was 36°·5, being 5°·3 colder than it was in 1863, and of lower temperature than any since 1861, when it was 33°·9.

The mean temperature of February was 36°·0, being 6°·1 lower than in 1863, and colder than any since 1860, when it was 35°·7.

The mean temperature of March was 41°·3, being 2°·6 colder than in 1863, and colder than any March since 1860, when it was 41°·1.

The mean temperature of April was 48°·2, being 1°·7 above the average of the preceding 23 years, and 0°·9 colder than 1863.

The mean temperature of May was 53°·8, being 0°·9 above the average of 23 years. It was 1°·8 warmer than in 1863, but 1°·6 colder than in 1862.

The mean temperature of June was 57°·4, being 1°·7 below the average of 23 years, 0°·7 below that of 1863, but 1°·1 higher than in the year 1862.

The mean temperature of July was 61½°, being ¼° above the average of the preceding 23 years, and but slightly different from that in 1863.

The mean temperature of August was 59°·6, being 1°·8 below the average of the preceding 23 years, and 2°·3 colder than in 1863.

The mean temperature of September was 56°·9, being of the same value as the average of the preceding 23 years, and 3°·2 higher than in 1863.

The mean temperature of October was 50°·5, being the same as the average of the preceding 23 years, 1°·1 lower than in 1863.

The mean temperature of November was 42°·0, being 2°·1 below the average of 23 years, and 3°·7 colder than in 1863.

The mean temperature of December was 38°·5, being 1°·9 below the average of 23 years, and 4°·7 colder than in 1863.

The degree of humidity of the air in the three months ending June was very uniform and about its average; the mean was 73, complete saturation being represented by 100. In the same months, in the years 1844, 1848, 1853, and 1858, the value of this element was the same, namely, 73; and it is the smallest value I can find back to 1841. In the years 1844, 1853, and 1858, this element, in June, was 67 or 68; in the year 1848, in May it was 63. The distinguishing feature of these three months in this element, as compared with those years, is therefore its uniform dryness. In the following three months the dryness of the air was remarkable: the degrees of humidity were 70, 65, and 77 for July, August, and September, respectively; their averages are 76, 77, and 81. There is no instance on record in the month of August of a humidity less than 69, which took place in 1849. In 1843 it was as high as 85.

The year, therefore, was cold and dry, with a preponderance of N. and E. winds, and a corresponding deficiency of S. and W. winds, and a fall of rain remarkable for its small amount.

Obituary

LIST OF PERSONS EMINENT IN SCIENCE OR ART, 1864.

WILLIAM BEHNES, eminent sculptor.

JOSEPH WOODS, architect.

CHARLES M'INTOSH, well known, particularly in Scotland, for his skill in architectural gardening.

HIPPOLYTE FLANDRIN, Member of the French Institute. He was the best-known pupil of M. Ingres, and famous as the painter of the frescoes in the churches of St.-Vincent de Paul and St.-Germain des Prés. M. Flandrin painted many large mural pictures in cathedrals and churches in France, and a great number of portraits. Several works by him were at the International Exhibition of 1862.

W. BUCHANAN, known as the author of several works on the Fine Arts, especially the *Memoirs of Painting, with a Chronological History of the Importation of Pictures by the Great Masters into England* 1824, a book of considerable value.

DR. J. R. BALLANTYNE, formerly Principal of the Government College at Benares, and latterly Librarian to the India Office.

JASMIN, of Agen, the last troubadour of France. His verses were written almost invariably in the Gascon dialect.

DR. WILLIAM CURETON, a profound Syriac scholar: his writings on Biblical and Theological subjects are numerous and valuable.

ARISTIDE HASSON, French sculptor, a pupil of David (d'Angers). His principal works in Paris are the statues of Bailly and Voltaire, in the façade of the Hôtel de Ville; Summer and Winter, two colossal figures in one of the fountains of the Place de la Concorde; and the statue of St. Bernard, at the Madeleine.—*Athenæum.*

DR. R. DUNDAS THOMSON, F.R.S., one of the founders of the Blenheim Free Dispensary; physician of the Scottish Hospital; a Fellow of the London and Edinburgh, the Royal Medical, and the Chirurgical and Chemical Societies; and President of the British Meteorological Society. Dr. Thomson, in addition to his medical labours, found time to write and edit several scientific works.

LEONARD HORNER, Inspector of Factories, and a younger brother of Francis Horner. Mr. Horner was a man of large attainments, not only in science, but in general literature. He died in his 80th year.

DR. BAIKIE, by whose death another link is added to the long chain of distinguished men who have perished in the cause of Africa.

AUGUSTUS DE BERGH, writer on speculative geology. He travelled much with Von Buch, and out of this friendship grew discussions of astronomical and geological questions; and in the mind of De Bergh, a theory of the connexion between the sciences of stars and strata, entitled "A Theory, or Considerations on the Motion of the Major Axis, or Revolution and Change of the Line of Apsides of the Earth's Orbit; its Causes, and the Effects produced in its Orbital Revolutions through the Ecliptic, from one Hemisphere to the other, involving a certain Number of Years." All the calculations in support of this theory were made relatively to the year 1830. A geological friend of the author published an account of his theory a few years later. Living a very quiet and retired life latterly, at Brighton, collecting and arranging a valuable private museum, Capt. De Bergh contented himself with explaining his views and lending his MSS. to his friends. Six or seven years since Mr. De Bergh himself published his *Essay on the Causes of Periodic Inundations.*—*Athenæum.*

JOHN WYKEHAM ARCHER, painter in Water Colours, and a popular writer on antiquarian subjects.

DR. SCHUBERT, a native of Leipzig, who was attached to the expedition in search of Dr. E. Vogel.

JAMES-MEYER-LIEBMAN-BEER, the last but one of the brilliant phalanx of German musicians belonging to the days of Beethoven, Weber, Mendelssohn, each differing from each, yet severally printing a name of mark on the record of the epoch.—*Athenæum.*

T. D. MARSHALL, maker of marine steam engines, and fitter-out of steam tugs, at South Shields.

THOMAS CASEBOURNE, C.E., of Hemel-Hempstead, Herts. He was a favourite pupil of Telford, the designer of the Menai Suspension Bridge, and the Caledonian Canal. Mr. Casebourne was one of the oldest surviving members of the Institution of Civil Engineers, having been admitted an Associate in 1828, and a full member in 1837. He was privileged to assist Mr. Telford in several of his works; and subsequently, amongst other duties, he was engaged in the Lincolnshire Fens Drainage, the London and Liverpool Road, the Metropolitan Water Survey, &c. From 1833, and for twelve years subsequently, Mr. Casebourne was engaged on canal works in Ireland, and the extensive canal connecting Lough Neagh and Lough Erne was constructed under his superintendence. In 1845 Mr. Casebourne removed to the locality now so well known as West Hartlepool—then a mere hamlet—to undertake the Resident Engineership of the West Hartlepool Harbour and Docks; and since that period his name has been intimately connected with all that related to the port, harbour, and town of West Hartlepool.

DR. CHURCH, the well-known mechanician. He was born in the State of Vermont, and was educated for the medical profession. At an early age he evinced a love for mechanics and an inventive genius: when a boy, the use of steam power being then in its infancy, he constructed a steam-engine. In 1811 he took out a patent for a screw-propeller, and asserted that eventually the ocean would be navigated by steam. About 1818 he visited England, returning in 1822, for the purpose of constructing a printing-press of his own design, and unique in many respects. One part of the plan, says the *Birmingham Post*, was to set the type by keys, acted upon like those of the pianoforte; but the design was abandoned. The press, however, was finished, and was said by some to be superior to Napier's, then recently introduced; but the *Times* and other large establishments having supplied themselves with this latter, the business was not continued. In the year 1825 the Doctor invented a mode of smelting iron by hot blast, and with anthracite coal, and took out a patent for the invention in America. Dr. Church resided in Birmingham until about five years ago, when he retired to his native place, Vermont, where he died in his 85th year.—*Mechanics' Magazine, in part.*

PROFESSOR SILLIMAN, the well-known American *savant*. The many volumes of the *Journal* which bears his name attest his important contributions to science. A private letter says:—"He was a noble, generous-hearted Christian gentleman; with him science and religion went hand in hand. Ever cheerful and happy himself, he tried to make others the same, and died, as he had lived, one of the best of men." He was in his 85th year.

ADOLPHUS BERNAYS, Doctor of Philosophy, and late Professor of German Literature at King's College.

CHARLES WINSTON, the highest authority in the art of painting on glass: with his own hand he copied from the originals a very great number of the best-known examples, and his copies are marvellous productions, portraying not only the exact colour and drawing, but the genius and the minutest detail of the designs. So accurate was Mr. Winston's knowledge that he could at once, and with certainty, determine the date and the history of any glass presented to him; he made himself master, also, of glass manufacture, both ancient and modern, and of the chemical properties of the materials of its composition and colour.—*Athenæum.* Mr. Winston left several works on this subject; these contain not merely descriptions of the painted glass, but also notices of the mechanical process of glass painting, and suggestions for the improved cultivation of the art in this country, and on the principles on which it should be pursued.

DR. SNHNEIDER, the greatest German organ-player.

WILLIAM HUNT, the eminent painter in water-colours.

STEPHEN POYNTZ DENNING, well known as a water-colour painter and skilful copyist; and, for many years, the Curator of Dulwich Gallery.

The CHEVALIER FORTUNATO RIO CASTELLANI, whose classic necklaces, earrings, and bracelets have an European reputation, and in which the designs of ancient Etruscan art are rendered familiar to us.

LEO VON KLENZ, the eminent architect, of Munich.

JAMES MILLAR, Professor of Surgery in the University of Edinburgh. He was the author of *The Principles and Practice of Surgery*, which has passed through four editions in this country, and been several times reprinted in America. He was also the writer of the article *Surgery* in the *Encyclopædia Britannica*; and the author of *The Surgical Experiences of Chloroform*, and other works. He published a considerable number of tracts on temperance, of which he was a strenuous advocate: his treatise on *Nephalism* is an able scientific argument against the use of alcoholic liquors.

F. W. DELAUNAY, architect, of Bradford.

CHARLES SAUNDERS, the indefatigable Secretary of the Great Western Railway Company. "He devoted himself to the interests of the Great Western undertaking, and worked with unparalleled sagacity and labour—no matter what the result was, and we fear there is little room for doubting that his days were shortened by the wear and tear of the many conflicts that the Great Western has taken part in."—*Sherborne Journal.*

CAPTAIN SPEKE, the celebrated African explorer, whilst shooting near Corsham, Wilts: in getting over a stone wall, his gun was accidentally discharged, the charge passed through his chest, close to his heart, and he died in about ten minutes. Captain John Manning Speke was born near Taunton, in 1827: he entered the army in 1844. In 1854-5, in company with Captain Burton, he explored the Somali land in Africa, and had a variety of adventures, of which he published an account in *Blackwood's Magazine.* He returned to England in the summer of 1855, and joined the Turkish Contingent in the Crimea. At the close of the war he projected an excursion into the Caucasus, but accepted an invitation to join in an Expedition into the lake regions of Central Africa, whereof Captain Burton has published an account. They started from the Zanzibar coast in 1857, and reached the Lake Tanganyika at the foot of the Mountains of the Moon. Here Captain Burton was laid up by illness, and Speke pushed his way on to another large lake, which he reached August 3, 1858. This he named the Victoria N'Yanza, and declared to be in his belief the source of the Nile. He returned to England and obtained the medals of the Geographical Societies of England and France; and in 1860 he set out once more with Captain Grant as his travelling companion. The two travellers spent more than a year in the region between Zanziburn to Kehria N'Yanza and the Nile. This visit confirmed Captain Speke's belief as to the Nile taking its rise from a lake; and his adventures by this Expedition have been published in the well-known work which bears the joint names of Speke and Grant.

JOHN TAYLOR, long known as a publisher and as a writer on curious questions. Among his subjects were "Junius," "The Number of the Beast," "The Origin of the Pyramids," and "The Currency." Mr. Taylor will be remembered as the first who started "Sir Philip Francis as Junius," and his method of treating his hypothesis has gained for it a very wide adoption. Mr. Taylor thought much and collected carefully before he committed himself. His habits were of the most quiet and sedentary kind, and his conclusions were slowly wrought out: it is not a little singular that with such a character of mind he should have worked through such a curious mass of researches.

C. F. BIELEFIELD, modeller in papier-mâche: an excellent historical account of this art, by Mr. Bielefield, will be found in the *Literary World*, vol. iii., 1840.

MAJOR-GENERAL J. E. PORTLOCK, engineer and geologist.

WILLIAM DYCE, R.A., historical painter.

FRANZ XAVIER KEIM, German architect.

LUKE HOWARD, the well-known meteorologist.

JAMES PILLANS, writer on elementary and classical education.

GEORGE DANIEL, antiquary.

ALARIC A. WATTS, art-critic.

M. DUBOUFE, French painter.

LIEUT.-COLONEL TORRENS, political economist.

W. J. FOX, political economist.

J. F. FERRIAR, professor of natural philosophy.

DR. NORMANDY, long familiarly known as a practical chemist of reputation and an experimental philosopher who had contributed to the progress of modern science. In the course of his studies he formed an intimate friendship with the late Dr. Ure, with whom he was subsequently associated in many important chemical analyses. Dr. Normandy was the author of several works which stand high in the estimation of chemists. Among these are *An Introduction to Rose's Chemistry* (he also edited an English translation of that work); *The Handbook of Chemistry; A Treatise on Agricultural Chemistry; Guide to the Alkalimetrical Chest; The Chemical Atlas*—a work of great value to students of chemical analysis; *The Dictionary of the Chemical Atlas.* His latest literary labour was devoted to several contributions to the new edition of Dr. Ure's *Dictionary of the Arts and Manufactures.* Dr. Normandy had taken out patents for many useful inventions. The most important of these may be said to be his apparatus for the distillation of aërated fresh water from sea water. This invention has proved of the greatest value to transatlantic shippers, and assumed the position of a practical necessity for passenger ships and ocean-going steamers. Dr. Normandy has left a scientific name which will be long remembered with respect.—*Lancet.*

DR. RHUDOLPH WAGNER, of Gottingen, a successor of Blumenbach in the chair of Medicine in that University. His contributions to science were numerous. He was the German translator of Prichard's work on *The Natural History of Man*, in which he had a coadjutor. Of late years he has devoted his chief attention to the anatomy of the brain, especially to determining its weight and the form of its convolutions in the cases of men eminent for intellectual power. In conjunction with Prof. Von Baer, of St. Petersburg, he took the initiatory part in the assembling of a meeting of Anthropologists at Gottingen, in 1861. The great work on which Wagner's future fame will chiefly rest is that on the *Primitive Ovum*, in which he represented the *Ovum ovarii* in nearly all classes of the animal kingdom. His *Icones Physiologicæ* and his Zootomical Atlas have been and still are of great use to every one who studies comparative anatomy. He was a very accomplished man in the general field of the Medical Sciences. Latterly he became more and more convinced of the importance and value of craniology in the study of the natural history of man, and in the positive distinction of races.

GEORGE LANCE, painter: he greatly excelled in fruit subjects.

JOHN LEECH, caricaturist and popular illustrator of comic humour.

DAVID ROBERTS, R.A., painter: his architectural subjects are unrivalled.

DR. MUNRO, the distinguished amateur painter.

RICHARD ROBERTS, one of the oldest of our civil engineers, the constructor of the self-acting mules and machines for building with iron. As the inventor of the Jacquard punching-machines, for perforating rivet-holes, Mr. Roberts aided essentially the accomplishment of that great triumph of combined efforts, the Britannia Bridge. The machine had its part in the realization of the more extended work, the Victoria Bridge, over the St. Lawrence, Montreal. This invention was followed by one of a duplex machine for punching holes for rivets, in angle-iron. The whole course of his long life was devoted to the invention of labour-saving tools and machinery. Mr. Roberts, however, only realized the return of too many inventors. Having made the fortune of some of his associates, he had gained at the time of his death, in his 76th year, little but his reputation as an inventor. Mr. Smiles's account of Mr. Roberts, in the *Lives of the Engineers*, has some errors as to facts, which the writer of the memoir in the *Builder*, whence the above facts are taken, has corrected by recollection and the information of friends.

JOHN FOWLER, of Leeds, inventor of the Steam Plough. He died at Ackworth, near Pontefract, where he had gone to reside, as a means of isolating himself to some extent from the care and labour which attended the active personal superintendence of his works at Hunslet, Leeds, which are famous in the agricultural annals of this country. He was only 38 years old, but his health broke down through excessive and unremitting mental exertion. Relaxation from business and active out-door recreations were imposed upon him as indispensable necessities; and, acting

under professional advice, he lately began to join in the sport of hunting. While following the hounds, he fell from his horse, and received a compound fracture of one arm, of which, in a few days, he died.

Thomas Henry Maudslay, the eldest surviving son of the late Mr. Henry Maudslay, the founder of the well-known firm of Messrs. Maudslay, Sons, and Field. From the year 1810 to a very recent date, the deceased mechanician was an active member of the firm. He did not stand prominently before the world as the initiator of any notable improvement in Land or Marine engineering; but his zealous attention to the minutiæ of the workshop, and his great commercial qualifications, made Mr. Thomas Maudslay an invaluable assistant to his father, and a staunch pillar of the establishment subsequently to his parent's death. Many hundreds of vessels, belonging to the British Navy, to foreign governments, and to the commercial world generally, have been supplied by the firm, since 1814, with engines of an aggregate nominal horse-power amounting to that of 100,000 horses, and almost every pair of engines differs somewhat in details of construction. Iron boat-building on the Thames was initiated by the younger Maudslays, although it has now become a separate and distinct department of engineering. The introduction of the screw-propeller led the Messrs. Maudslay, in conjunction with Mr. Joshua Field—whose death took place last year—to try a series of experiments with almost every imaginable kind of propeller, with important results for the guidance of others. In nearly all these works Mr. Thomas H. Maudsley was practically engaged.—*Mechanics' Magazine, abridged.*

John Ramsay M'Culloch, writer on Political and Economical Science.

James Heywood Markland, D.C.L., a sound archæologist, and a scholar of high classical attainments.

Sir John Watson Gordon, portrait-painter, President of the Scottish Academy.

Nassau William Senior, a distinguished writer on Politics and Political Economy. Senior was twice appointed to the Chair of Political Economy at Oxford. He was the author of several works on his favourite science, his last volume being an account of his travels in the East.

The late John Taylor, F.R.S., F.G.S.—Of this eminent scientific man, who died in 1863, a notice was inadvertently omitted in the *Year-Book of Facts*, 1864. Mr. Taylor was the eldest of a Norwich family, distinguished for their talents. He was brought up as a land-surveyor and civil engineer; and, when 19 years of age, undertook to manage the Wheal Friendship, near Tavistock, a mine which, under his care, became very profitable, and the working of which is still continued. In 1803, he projected the Tavistock Canal, with three miles tunnelling through a hill of granite and other hard rock. The execution of this canal led to the discovery of Wheal Crown-dale and Wheal Crebor, both which produced large quantities of copper. This, and other successes in Cornwall and the north of England and Wales, brought Mr. Taylor into great repute as a mining engineer. In 1824, having explored the mineral wealth of Mexico, his co-operation was sought, but he would not lend his name to mere speculation: his experience was not appreciated, though mines abandoned in 1824 have since become remarkably successful. Mr. Taylor's firm numbered some of the best mines of the day. He wrote several useful papers connected with mining; proposed a Mining School; and was one of the earliest Fellows of the Geological Society. He was also one of the founders of the British Association, and its Treasurer until the year 1862, when his resignation was reluctantly accepted.—*Abridged from an excellent article in the Mining Journal*, April 11, 1863.

Professor Wilhem Vrolik, who died December 24, 1863, occupied with distinction the chair of Anatomy, Physiology, and Zoology in the Athenæum of Amsterdam for more than 30 years. His works are mostly on Comparative Anatomy, chiefly Mammalia, and upon Morbid Anatomy.

GENERAL INDEX.

THE END.